Enigma Reference Manual

for version 1.30

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1 Running Enigma

Hopefully, after successfully installing and playing some first levels, you may be interested in some information about how we have configured Enigma, how you can optimize Enigma to your needs, and the purpose of some options and attributes within Enigma.

This first chapter should give you some valuable information about these questions, and provide some basic knowledge you will need to manage level packs, levels or write your own levels, as described in the following chapters.

1.1 Locating Resources

For reasons of backup, system changes, special configurations, level additions and hopefully your own new levels, you may need to know where Enigma stores the resources and how you can control them.

Enigma maintains several paths for control of load and storage of files. You can list these paths either in the help submenu paths, or by starting Enigma with the switch `--log` (see Section 1.2 [Startup Switches], page 2) and looking at the console output.

Preferences Path

This is the path to the file that stores your preferences concerning application options. This file is usually located at your `HOME` directory. For `HOME`-less Windows users, it is stored in the '`Application Data\Enigma`' directory. Since it is the third version in the history of Enigma, the file is named '`.enigmarc.xml`' by default.

We recommend that you backup this file, although it contains only a few data that you can quickly reconfigure.

Since these preferences are quite specific for the operating system and configuration, you will use a different version on each Enigma installation you have.

Mainly for Enigma developers, a switch exists `--pref` (see Section 1.2 [Startup Switches], page 2) to rename this preferences file. By starting Enigma with a renamed preferences file, a developer can temporarily use a complete separate configuration for testing purposes without the danger of destroying his main configuration. The developer may use it to start Enigma with a plain standard configuration for testing purposes, too.

In all cases, a leading '`.`' will hide the preferences filename.

User Path

This is the main path to the user's Enigma data. All updates, user-installed levels and user- written levels, the user's scores, history and usually the user's screenshots and level previews, are stored at this path.

A backup of this directory is mandatory!

The standard location is the directory '`.enigma`' in your `HOME` directory. For `HOME`-less Windows users, it is the folder '`%APPDATA%\Enigma`', what resolves to the subfolder '`Application Data\Enigma`' on XP/2000 or '`AppData\Roaming\Enigma`' on Vista/Windows 7 located within your user data folder.

This standard location of the user path is the location of logging and error output files, too.

You can define your own path within the Section 1.3 [User Options], page 4. By doing so, you can store your Enigma user data on a memory stick or on a shared partition, and use them alternatively from two Enigma installations.

User Image Path
: This is a second path to the user's Enigma data, which you can use to access images such as screenshots and thumbnails of levels. Usually this path is identical to the main '`User Path`'.

  Just in case you make many screenshots and have limited resources on the main '`User Path`', you may want to store the images on another path. You can define your own path within the Section 1.3 [User Options], page 4.

System Path
: This path gives you the location of all system resources that are distributed with Enigma. Here you will find the levels, libraries, etc. This is a first class address to look for examples if you start writing your own levels.

Resource Paths
: This is a list of paths. The program looks up each version-independent resource on all paths in this list, and loads from the first occurrence.

  User data precedes system data; this way, updates on your user data path will win. Have a look at this list if you are observing a difference between a source and the runtime behavior. You may have looked at a file that another file had hidden on a preceding path in this list.

l10n Path
: This path shows the directory that contains the localization data.

Please note that some resources, like levels, may be zipped. In this case, a resource that you expect to find at '`dirname/filename`' may be stored in a zipfile named '`dirname.zip`'. The path of the file within the zip can be either '`dirname/filename`' or '`./filename`'. In case a resource is provided in zipped and unzipped form, the plain file stored in a directory wins, since Enigma assumes it to be an update to the zip.

1.2 Startup Switches

Besides starting Enigma by clicking on an installation-provided icon or start menu entry, you can start Enigma from a shell or commandline. This allows you to add a selection of startup switches that are valid for just a single run.

For repeated usage of constant startup switches you can create a desktop icon or start menu entry and append the startup switch to the target string of the Enigma application executable.

The following list explains the supported user options. If an option is listed with a long name preceded by two minus signs, and with a one-character abbreviation preceded by one minus sign, use one of the notations, not both together; for example, '`--data path`' or '`-d path`'.

--assert
: A switch for Enigma developers that forces all debugging assertions, even expensive ones, to be evaluated. The additionally evaluated checks look like '`ASSERT(noAssert || long_lasting_check(), XLevelRuntime, "remark");`'.

--data -d path
: A switch for Enigma developers that allows you to add an additional path to the resource paths that precedes the system path (see Section 1.2 [Startup Switches], page 2). A developer can test an Enigma compilation, without installation, by calling it from the shell with the current working directory on the main directory via '`src/Enigma -d ./data`'.

--help -h
: Just lists the available startup switches to the output and terminate.

--lang -l lang
: A switch that allows you to override any other language preference. The language is given in the common 2-character sequence as '`fr`' for French or '`ru`' for Russian.

--log
: This switch turns on logging of internal information to the standard output. Windows users will find a file called '`Output.log`' in the standard '`User Path`' folder. An additional file '`Error.log`' lists severe error messages.

  The output will, for example, list the paths described in Section 1.1 [Locating Resources], page 1.

--nograb
: A switch for Enigma developers that causes Enigma not to grab the mouse. You can hardly play a level in this mode, but it makes it possible to debug the application in its core parts.

--nomusic
: Start Enigma without playing background music.

--nosound
: Start Enigma with sound being switched off.

--pref -p filename
: The name of an alternative preferences file without the leading dot for hidden filenames. This switch is a pure Enigma developer support feature, as described in Section 1.1 [Locating Resources], page 1.

--pref -p dirpath
: The path of an alternative directory that contains the standard named preference file '`.enigmarc.xml`'. If no preference file exists or the directory does not yet exist they are created. On creation of the preference file the user data path is set to the given dirpath per default. This allows to store all Enigma user data in a single directory that can be stored anywhere, e.g. on a USB stick. You always need to call Enigma with the above switch to use this new set up. Remember that a path with spaces needs to be quoted.

--redirect
: Redirect the '`stdout`' and '`stderr`' to files named '`Output.log`' and '`Error.log`' on the standard user path (see Section 1.1 [Locating Resources], page 1). For Windows this option is always `true`, but the usage of this option is useful on any operating system if Enigma is started via a desktop icon or a menu button.

--robinson
: Disable all connections to the internet. No automatic updates will take place and all user initiated requests that would require an internet connection will fail with an error message.

--showfps
: Show the framerate (FPS) during the game.

--version Just print the version number to the output and terminate.

--window -w
Start Enigma in window mode instead of screen mode.

Enigma interprets all further arguments supplied on the commandline as level file addresses. You can use absolute or relative addresses to level files stored on your computer. Adding url's to levels stored in the Internet is also possible.

A Unix user may start Enigma with the following command:

```
enigma --log ~/mylevel.xml http://somewhere.com/netlevel.xml
```

A Windows user may start Enigma from the command line (please adjust the Enigma installation path):

```
C:\Programs\Enigma\enigma.exe --log demo_simple.xml
```

You will find these levels in the levelpack called '`Startup Levels`', which is only visible by default if you supplied levels on the commandline.

1.3 User Options

Ratings update
Please retain this option on the value '`Never`' until release of Enigma 1.00.

User name
Enter your user name, which Enigma will attach to your scores. Please look at the Enigma home page for user names already in use and choose a new, unique name. You can change your user name at anytime without losing any of your scores.

User path This textfield allows you to define an arbitrary directory for your Enigma user data as described in Section 1.1 [Locating Resources], page 1.

Deletion of the string resets the path to the default.

Enigma activates the new path when you leave the options menu. Though it stores all files directly to the new path, and will still find files on the old path, you may want to quit Enigma immediately and first copy/merge the old directory to the new location. This copy of your old data is necessary, since with the next start, Enigma will locate user data at the new location exclusively.

User image path
This textfield allows you to define an arbitrary directory for your Enigma user image data as described in Section 1.1 [Locating Resources], page 1.

Deletion of the string resets the path to the default.

Enigma activates the new path when you leave the options menu. Though it has stored all files directly to the new path and files will still be found on the old path, you may want to quit Enigma immediately and first copy/merge the old directory to the new location. This copy of your old data is necessary, since with the next start, Enigma will locate user data at the new location exclusively.

1.4 Inventory Console

The lower right window area that usually shows the inventory items and scrolls the texts of activated document items allows the user to reread previous document texts, to enter textual commands and to reissue previous commands.

You can issue a command by usage of the keyboard. Just enter the command string and activate the command by a finishing `return` stroke. The following commands are supported:

help List all public available commands.

abort Abort level and return to level selection menu. Same as `Alt X`

April 1st Just a joke.

cheats List level developer cheat commands for fast testing.

collision Developer cheat that disables collisions between stones and marbles or pearls. Once used no score will be recorded if the level is successfully finished.

easy Restart level in easy difficulty mode.

find search_string
Searches levels in all levelpacks that contain matching string in either the level's title, author's name or the file name.

god Developer cheat that protects the actors assigned to the current player like the activation of an Section 8.3.32 [it_umbrella], page 207, does. Once used no score will be recorded if the level is successfully finished.

hunt Switch to world record hunting mode. Same as toggling the left most button in the level selection menu to the world icon.

info Show info about level like the levelpack, position within levelpack, the file location, the title, author, version and the level internal id.

jumpto levelpack,position
Directly start the given level. The levelpack is identified by its title. The position is the number within the levelpack. E.g. `jumpto Enigma IV,33`.

nohunt Switch off the world record hunting mode. Same as toggling the left most button in the level selection menu to the marble icon.

regular Restart level in regular difficulty mode

restart Restart level in currently selected difficulty mode.

suicide Kill actors, but continue level if possible. Same as `F3`.

Both, the commands and the displayed document text have a history. You recall the history by usage of the up and down arrows.

- **inventory** –> jump to start
- **command #10**, oldest command in history
- **command #9**
- . . .
- **command #2**

- **command #1**, last executed command
- **command under edition**, just if the last edited command has not been executed
- **inventory** <– start
- **document #1**, last viewed document
- **document #2**, previous viewed document
- ...
- **document #n**, first viewed document
- **level title, subtitle, author**, as shown on level start
- **inventory** –> jump to start

Starting with the inventory item display the up arrow shows the previously submitted commands. Just by another `return` you can reissue a command. The history will be resorted with the last command at the position direktly above the inventory. You can edit history commands anytime like you can insert a new command. If you do not finish a command by a `return` the string will still be recorded and presented as the first command above the inventory. The command history is persistent.

The document history can be recalled by usage of the down arrow. All level documents previously displayed can be redisplayed. Additionally the initial level info displayed on the level start can be read again.

Both histories revolve to the item inventory when the up or down keys are used beyond the oldest command or message.

1.5 Level Info

For every level, Enigma manages more data than can be displayed in the level menu. You can view them all with the levelinspector. You can call this special menu from within the level menu by right or control clicking on the level icon.

Besides title and author, Enigma provides information concerning a public rating of the level, different score values of interest, details on the level version, the level file location and more. Additionally, the levelinspector allows you to enter personal annotations for a level. You can review any screenshots you made for this level directly from the levelinspector, too.

1.5.1 Public Ratings

Most levels are rated within five different categories:

- int = Intelligence
- dex = Dexterity
- pat = Patience
- kno = Knowledge of Enigma
- spe = Speed and Speed control

To distinguish the ratings from their everyday-meanings, we use the following abbreviations for the ratings. Each of these categories takes values between 1 (easy) and 5 (difficult), except kno, which can also be 6 (unique mechanism).

Please bear in mind that it's not simple to retain the following definitions in each of nearly 750 cases, so there might be (will be) deviations from them in single levels.

Intelligence (int)

This rating is intended to measure the creativity, planning and analytic requirements needed to solve the level. Intelligence is a very difficult concept in itself, and thus at first not easy to rate or to grasp. Consequently, a fixed definition of the five rating-degrees not only helps, but is essential in the rating process. So, assume you know everything about the single elements of a level. Then ask yourself these questions:

- Can I see the solution at once? Yes -> int 1
- Do I only have to orient myself, for example, testing the exits of wormholes or to see the function of a switch? -> int 2
- Is there a standard algorithm to solve the problem, like in a maze, or searching for a hidden item? -> int 3
- Neither trial-and-error nor standard algorithms work; is it a simple kind of code or does it require advance planning? -> int 4
- Is it a difficult code, pattern or causal chain? -> int 5

High values for intelligence are typically puzzles. int-ratings do not accumulate; the most difficult puzzle itself already determines the rating.

Dexterity (dex)

You can solve many levels either by accuracy or by patience. In our context, we do not mean dexterity in the sense of accuracy to avoid impatience, but accuracy to avoid death. So it focuses on the lethal positions in a level, not only death-stones and abysses, but also casualties like pushing a stone accidentally into an unreachable corner.

- It doesn't matter what I touch, this level is damn-proof. -> dex 1
- Well, there are lethal positions I shouldn't move the level into, but they are not difficult to overcome. -> dex 2
- Comparable to a single row with an abyss left and right. -> dex 3
- Comparable to pushing a stone to the right with an abyss on the left, or a single row with death-stones left and right. -> dex 4
- Needs lots of attempts to succeed. -> dex 5

In contrast to the int-rating, dex might accumulate: A level with many situations, each of dex 3, can add up to dex 4 or even 5. This way, you can achieve dex 5. Rotors in a level also contribute to dex and to the speed-rating, spe. Thus, levels with a high dex-spe-combination are mostly action-driven, whereas a high dex-pat-combination typically is a dangerous maze.

Patience (pat)

Patience is a relatively subjective rating, and refers mostly to “felt time”, how long it felt to complete the level. So two levels with same mechanics can have different pat-values, e.g., if one level has a nicer design or shows the progress of the level in some way, like the number of opened oxyds. It explicitly includes having to restart the level repeatedly; not the time in the lower left corner or the score is crucial, but the complete “felt time” needed to solve the level, starting from the first look at it.

- I solved the level right after understanding it. -> pat 1
- I needed some time, but it wasn't boring. -> pat 2

- Okay, it took some minutes, but the landscape is nice . . . -> pat 3
- I know what to do, but it doesn't seem to end. -> pat 4
- This level really requires discipline. -> pat 5

A high number of oxyds can heighten the pat-value and also lower it: If the player has to traverse the level several times to open matching pairs of oxyds, it is definitely pat-heightening. However, if oxyds are arranged to mark the progress of the player, and act as a kind of small reward within the level, they can lower the pat-value. It's the same with a high number of doors: The arrangement is the critical factor.

High pat-values are typically mazes. In combination with int 3, a high pat-value can indicate a hidden item or a hollow stone. pat-values involve the whole level, so they can't accumulate.

Knowledge of Enigma (kno)

The kno-rating mostly takes on the function and interactions of single objects in the game, like stones, floors, items, and actors. However, in some cases it also deals with special techniques. The guideline is the "Advanced Tutorial", which defines kno 3. kno 4 corresponds to standard objects that aren't shown in the tutorial; kno 5 requires a deeper knowledge of the game internals. Finally, kno 6 indicates special mechanisms, that are seldom encountered or unique. The overall kno-rating of a level equals that of the most difficult object or technique (and thus is non-accumulative):

1. Moving a single marble on normal floors, normal walls, oxyds, stones that look like oxyds, death-stones, water, an abyss, documents, using the inventory, static gravity, visible gradients.
2. Pushing stones, simple Sokoban-tricks, bridge-building in water and an abyss, connected puzzle-stones, moving more than one marble, meditations, grates, rotors and tops, hidden gradients, triggers and switches, doors, holes (not made by dynamite), swamp, floppies and st-floppy, keys and locks, coins and slots, cracks, timer-stones.
3. Different floors can have different friction and mouseforce, space, ice, inverted floor, some stones sink while others swim, black grates that hold rotors and tops away, dynamite, dynamite-breakable stones, spade, boulders, magic-wand to change boulder-direction, boulders sink into an abyss, sheets of glass, spoon, actors and items may hide under movable stones, small not-killer whiteballs, coloured one-way-streets, actorimpulse-stones ("bumpers"), rotors can fly over an abyss, quake-stones, swords and knights, lasers, static and movable mirrors, item- and coin-transformations by pushing stones over them and by using lasers, umbrellas protect in an abyss, hammer and breakable stones (although not in the tutorial).
4. Bridge-building in swamps, rubber-bands, rubber-band-stones, scissor-stones, unconnected puzzle-stones, exploding puzzle-stones, turning puzzle-stones (with and without a magic wand), springs (both types, on the floor and hole-kind springs like in "Upstream Journey"), thieves, three-part shogun-stones, invisible stones, hollow stones, chameleon-stones, items hidden under chameleon stones, stones that aren't what they seem (e.g., fake-death-stones), wormholes, magnets, using F3 for a restart to solve a level, yin-yangs, one-color-, yin-yang- and inverted yin-yang-stones, stones breakable by only one color, killer-balls, swap-stones, brush and paintable stones, changing one-way-streets with a magic wand, changing stones to glass with a magic wand, impulse-stones

(movable, static and hollow), black and white bombs, bomb-stones, fire, extinguishers, rotator-stones, yellow anti-swapping stones, mines, flags, seeds, weights, putting objects under one-way-streets and other hollow stones, electric stones, turnstiles, mailing and pipes, rings (single and multiplayer), volcanos, bags, randomizers (as possible effect of a switch), horses (the actors) and horse-passing stones, pins, bananas, cherries can make you invisible, surprise-item.

5. Cracks, floor-springs, wormholes, etc., are all items, seeds can grow inside stones, the laser is blocked by all items, killer-balls don't sink in water, "Space Meditation"-kind collisions, holding down the mouse-button, invisibility lets you go through glass, jumping over lasers . . .
6. Spitter-stones, surprise-stones, levels like "Enigris" or "Flood Gates" . . .

kno 6 does not necessarily mean that this level is difficult to understand; the unique mechanism or object might also be very intuitive, like in "Flood Gates".

Speed and speed control (spe)

The spe-value corresponds not only to the maximum speed a level requires (like you need to run away from a rotor), but also the degree of control a player has over his mouse while moving it; excellent examples for this are "Mourning Palace" and the middle part of "Sacrifice". This involves moving the mouse at a constant velocity for a long time, as well as correctly estimating the speed that's needed in a certain task, like shattering a sheet of glass.

1. No time limit.
2. You shouldn't stop for too long. For example, something slow might be chasing you.
3. There is an appropriate time limit or speed control task. This can be a single, not-too-fast rotor in an open area.
4. Don't stop! Examples include difficult timing-tasks as well as a single fast rotor or several slower ones.
5. Hurry Up! Whereas spe 4 is meant to be difficult, but obviously solvable in not too many attempts, spe 5 is everything beyond this.

The spe-rating again is cumulative, since many slow rotors can add up to spe 3 or 4, or a combination of many slow time-switches to be pressed in a certain order can create a horrible task. In contrast to the other categories, for which the average is near 3 (or between 3 and 4 for kno), most levels are definitely spe 1. So, the spe-rating is more a supplement to the three core-ratings int, dex and pat.

Combinations of ratings

Sometimes, it can be interesting to have a single value to measure the difficulty of a level. To calculate such a universal rating, a simple possibility is choosing a linear combination of the 5 single ratings, weighted with appropriate weights. These weights should correspond to the difficulty a single category adds to the universal difficulty. Yet you should also choose these weights carefully to avoid number-theoretic obstructions (e.g., when all weights are even except for the spe-rating, then there will be a visible difference in the distribution of even and odd universal ratings, which can be very misleading). A working, and very interesting linear combination, is the following, which has been applied in the reordering process:

```
universal difficulty  =  7*int + 6*dex + 4*pat + 3*kno + 4*spe - 23
```

This has a special property, in that it takes relatively broad and continuously distributed values between 1 (all ratings 1) and 100 (all ratings 5, kno 6) and emphasizes the most difficult categories, intelligence and dexterity. However, some very low or very high values cannot appear in this combination, such as 2 or 99. Other combinations lead to full but narrow, or to broad but noncontinuous spectra.

1.5.2 Scores

The score columns show your and some comparison values for the difficult and for the easy mode, if the levels supports it.

The world record is the best score that was retransmitted to the Enigma team. The world record holders are listed below.

The PAR value is the “professional average rating” of the level. It is the harmonic average of all scores that Enigma players have retransmitted. However, we take into account only scores from players who have solved a certain number of levels. Opposed to the world record, which will be very difficult to gain, the PAR value is a much more realistic aim for an ambitious player. If you are equal or better than PAR, the levels are marked with a speeding blackball within the level menu.

The author’s value is another reference score. Most authors are not keen on holding the world record of their own levels. However, they will likely know the fastest way to solve the level. If your score is much higher than the author’s score, a simpler solution to solve the level may exist.

The solved number is the number of players who solved this level in the given score version.

The solved percentage is the relation of the number of players who solved this level to the number of players who retransmitted scores. Actually, we take into account only those players who could have solved the level. For example, players who did retransmit scores before the level was written, without updating afterwards, are not taken into account. A low percentage is a hint that a level is not easy to solve.

1.5.3 Versions

The version column shows detailed information about the level. Read the chapter Level Basics node see Section 3.3.2 [<version>], page 30, and see Section 3.3.7 [<modes>], page 35, for an explanation of the values.

For you as a player, the ‘`Score`’ version number can be interesting. A level you had solved with a certain score may appear with a red triangle in the level menu in an updated Enigma release of the level. Although the level menu displays the medals showing that you solved the level, it will not display the score values anymore. This is due to an incompatible level update that requires a new solution with different, incomparable score values. The author will increase the score version number in such a case.

1.5.4 Private Annotations and Ratings

This textfield allows you to enter an annotation for a level that you can review on later replays. Note that the current textfield is limited (it may not allow you to enter all characters, and needs the mouse cursor to remain within its boundaries). Yet it should work for entering short annotations that may be very useful later.

Enigma stores annotations in your private applications '`state.xml`' file. It permits one annotation per level, independent of the level version.

You may rate the levels, too. Just click on the ratings button. Values go from 0 to 10 with an additional '`-`' for abstention. 0 stands for a poor level that you think is not worth playing, 5 for an average level and 10 for the ultimate, best levels. Try to use all values in your ratings.

Enigma stores the ratings with the scores and evaluates them anonymously. Enigma displays the resulting average rating of all users, for your information. Note that different ratings are possible for different score versions of the same level, because levels may improve as a result of suggestions by users. If you do not re-rate a new version of a level, Enigma inherits your rating from a previous version.

1.5.5 Screenshots

While playing a level, you can make screenshots by pressing `F10`. You can make several screenshots in sequence for documentation purposes. Enigma will store each with a unique image filename. Using the level inspector, you can view the screenshots directly from within Enigma. Just click on the screenshot button to view the first image.

Because any buttons would disturb the view of a screenshot, all functions are keyboard commands. Press `F1` to get a help screen. `ESC` returns to the level inspector. `Page Up` and `Page Down` will show the previous and next screenshot. If you scroll down behind the last screenshot, the "missing" screenshot file is named. This may be a useful hint as to where to search the other screenshot files on your '`user image path`' (see Section 1.1 [Locating Resources], page 1).

1.6 Handicap and PAR

As PAR (see Section 1.5.2 [Scores], page 10) describes the difficulty of a level, the handicap '`hcp`' describes your ability to solve levels in PAR. The handicap is always related to a levelpack or group of levelpacks. You can see your handicap for each levelpack in the level menu, if you select the PAR mode by clicking on the lower left button until the speeding black marble appears. The value is displayed in the upper right corner, with the number of levels you solved in PAR.

The handicap is similar to the golfer's handicap. A low value is better than a high value. If you solve all levels exactly in PAR, your handicap will be 0. If you are even better than PAR, your handicap will be negative. Players can use this value to compare their overall abilities.

Just for those of you that want to know the details of this score rating system of PAR and handicap, here is some additional information, which others may skip and continue with the next chapter Chapter 2 [Levelpack Basics], page 15.

We request all users to send their scores. All scores are evaluated for world records and counts of level solution rates and numbers.

However, for the PAR calculation, we take into account only scores from users who have solved more than a certain percentage of levels (currently about 10% of the levels). For every level, we calculate the harmonic average of the scores of these '`professionals`'. We take professionals who did not solve a level into account with the 10-fold world record score. The harmonic average calculates as harm.avg. = N / (sum_[j=1..N] 1/score_j))

It weights small (short) times with a greater weight than large (long) solution times.

The handicap is a sum of values that describe your scores in relationship to the PAR value of a level. Since it has to take into account that you have no score at all or that no PAR value exists, we apply some exception rules to the addends:

•	+ 1.0	for each unsolved level
•	+ log10(score/par)	for each solved level with existing par if score >= par
•	+ 0.7	as upper limit for each solved level with existing par if score >= par
•	+ log2(score/par)	for each solved level with existing par if score < par
•	- 3.0	as lower limit and as value for levels without par

Note that each score that is better than PAR results in a negative addend and thus reduces your handicap. For a levelpack with 100 levels, the handicap will be in the range of +100 to -300. For levelpacks with more or fewer levels, Enigma will scale the sum by a factor 100/size to result in comparable handicap values. Handicaps are stated with one digit behind the decimal point.

1.7 User Sound Sets

(The following information accounts only for Enigma 1.01 and above.) Sound effects are triggered by so-called '`sound events`'. These sound events usually have a name (like '`dooropen`') and an associated location (the coordinates of the door) which affects the way a sound effect is played. The collection of all sound files, their assignment to sound events, and some additional information how to play them is called a '`sound set`'.

You can use own sound files to create own sound sets for Enigma, and choose among them in the options menu (entry '`Sound set`'). You can distribute these sound sets under your own choice of license and install sound sets from other users. There is no internal limit for the number of installed sound sets.

The sound event is converted into a real sound effect using tables, you can find such tables in the '`data/sound-defaults.lua`' file and in the empty sample file at '`reference/soundset.lua`'. Each entry in these tables is either a string like '`enigma/st-coinslot`', which is interpreted as the file '`soundsets/enigma/st-coinslot.wav`' with some default properties, or a list of sound attributes enclosed in curly braces. Sound events triggered by a Section 6.2.12 [sound], page 132, message are converted the same way. Here is an example of such an entry:

```
dooropen = { file="my_soundset/open-door", volume=0.9, priority=4 },
```

The meaning of these attributes is as follows:

- '`file`' Path and name of the sound file for this event, without the '`.wav`' extension.
- '`volume`' The sound volume: 1.0 is default, 0.0 is silent.
- '`priority`' If many effects are active at the same time, high-priority effects can replace lower-priority effects. Use an integer between 1 and 10 (default 1). This property does not yet work with Enigma 1.01.

- '`global`' Either '`true`' or '`false`'. If true, no stereo effects are applied and there is no attenuation. Used for menu sound, level end sounds, etc. Default is '`false`'.
- '`loop`' '`true`' or '`false`'. If true, the sound repeats infinitely until canceled. Default is '`false`'.
- '`damp_max`', '`damp_inc`', '`damp_mult`', '`damp_min`', '`damp_tick`' Parameters for sound damping. Sounds from noisy objects like light passengers are damped to reduce the noise. For this, the sound event's frequency is estimated. '`damp_max`' calibrates the maximal damping factor (high means quiet), '`damp_inc`' how fast the damping accumulates, '`damp_mult`' is an overall factor, '`damp_min`' defines a lower bound for the damping entries (beyond which they are removed from memory) and '`damp_tick`' the factor that's applied all 0.1 seconds. See '`sound.hh`' for details. Defaults: 10.0, 1.0, 1.0, 0.5, 0.9.

To design a new sound set, proceed as follows:

1. Create a new folder containing a copy of the sample file '`soundset.lua`' and the wav files you want to use.
2. Move this new folder into Enigma's "soundsets" folder in your user path. (Possibly you have to create it.) The directory structure should look something like this:
```
(user path)/soundsets/my_sounds/
                               /soundset.lua
                               /high_pitch.wav
                               /soundfile_13.wav
                               ...
```
3. Run Enigma and choose '`My Soundset`' in the options menu. Since this file's sound set does not map any sound effect to a wav file, you should hear nothing.
4. Edit the contents of '`soundset.lua`' to your liking. You can access the default sound files, e.g.:
```
...
coinsloton = { file="enigma/st-coinslot" },
...
```
When using own sound files, remember to add the subfolder, like in
```
...
coinsloton = { file="my_sounds/soundfile_13" },
...
```
No extension ".wav"! It's added automatically. Make sure that the extension is in lower case letters.
5. Replace '`MY_SOUNDSET`' by a suitable variable name, and '`My Soundset`' by the name you want to see in the sound options menu. Remember to make it short enough to fit on the button. The three identifiers variable, button name, directory name need not have the same names, but it eases the life of other developers to give them similar names that uniquely determine the sound set.

Remember to choose the sound set in the options menu anew each time you change its name. And always shut down Enigma before changing sound sets, new sounds are not recognized during runtime.

Feel free to zip and distribute the whole directory containing your sounds and the '`soundset.lua`' file. You can install a downloaded zipped sound set simply by unpacking it and placing it into the '`soundsets`'-subdirectory of your user path. Make sure that the '`soundset.lua`' is always exactly one subdirectory below '`soundsets`'. Deinstall a user sound set simply by deleting its directory. Renaming the directory does not suffice – you have to rename the '`soundset.lua`' if you want to hide a sound set from Enigma. This can be advantageous if you use interdependent sound sets (sound sets that share sound files) and want to deactivate just one of them.

2 Levelpack Basics

Knowing the basics of running Enigma, you may wonder how levels are organized in levelpacks and how you can add levels or complete levelpacks to Enigma.

Levelpacks are sorted collections of levels that consist of an index and optional attached level sources. Not all level sources of a levelpack have to be included within the levelpack itself. A levelpack can crossreference levels stored in other levelpacks. If a levelpack has no level sources of its own and consists only of crossreferences, we speak of a crossindex, since just a single index file represents the levelpack.

These definitions suit all versions of Enigma well. However, up to Enigma 0.92, levelpacks needed to be manually edited, and the registration of levelpacks was a little bit cryptic. Thus, we decided to rewrite the complete levelpack system for Enigma 1.0, and tried to make it versatile and easy to use. We did set up the following aims:

- an '`Auto`' levelpack that allows level addition by drag and drop of the level source
- levelpack addition simply by copying the files to the userpath
- autodetection of all levelpacks without editing any registration files
- commandline-supplied levels as a standard levelpack
- a '`History`' levelpack with crossreferences of last-played levels
- level search results as a levelpack of crossreferences
- zipped levelpacks that are just archives of levelpack directories and their files
- grouping of levelpacks in the menu
- integrated composer to create and modify new levelpacks
- updates of levelpacks without updating Enigma itself
- automatic conversion of Enigma 0.92 levelpacks

Some of these features work seamlessly. You can use them immediately from the levelpack menu. For others, you may need to know where to place files. We will explain these details in the following sections:

2.1 Getting Started with Levelpacks

One of the outstanding features of Enigma is its extensibility by new levels. And the community of users usually provides us several new great levels every week.

Adding a new level that you receive as an XML file is very simple. Locate the subdirectory '`levels/auto`' on your '`user path`' (see Section 1.1 [Locating Resources], page 1). Just copy the level file to this folder and restart Enigma. The new level will be part of the '`Auto`' levelpack, and you can play it like any other level.

Please note that Enigma displays erroneous or incompatible levels with an error icon in the level menu. Of course an attempt to run such a level will result in an error message. Look at the level metadata with the levelinspector (see Section 1.5 [Level Info], page 6) to identify the required compatibility version, and contact the author via the address in case of level code errors.

A second way to run new levels is to add the address of the level files to the commandline (see Section 1.2 [Startup Switches], page 2). This way you can play levels that are stored anywhere, and you may even use url addresses of levels stored on the internet. Levels added to the commandline are accessible via the '`Startup Levels`' levelpack.

If you want to run an old-fashioned Lua level that someone wrote for Enigma 0.92 or earlier, you may try to start it via the commandline. These old levels miss necessary metadata for auto detection. However, commandline-supplied levels are treated as temporary levels available just for a single run of Enigma; reasonable defaults substitute the missing data. The level will probably run, but scoring and copy, paste and linking of such levels is not possible.

Besides single new levels, the community may provide you with complete levelpacks, too. These levelpacks may occur as directories with levels, zip archives or single XML files. You can install all of them simply by copying the files, but we have to distinguish the three formats.

You must copy levelpacks distributed as directories, with level files and an index file in them, to the subdirectory '`levels`' on your '`user path`' (see Section 1.1 [Locating Resources], page 1).

You must copy levelpacks distributed as zip archives to the subdirectory '`levels`' on your '`user path`'. You do not need to unpack the zip, although it is possible, as described in the section Section 2.3 [Zip Levelpacks], page 17.

You must copy levelpacks that are distributed as a single XML index file to the subdirectory '`levels/cross`' on your '`user path`'.

All new levelpacks should be accessible via the levelpack menu after restarting Enigma.

That is all you need to know to be able to add new levels and levelpacks for testing and playing. If your main interest lies in writing your own levels, you may want to proceed directly to chapter Chapter 3 [Level Basics], page 21. The rest of this chapter explains how to arrange and sort existing levels in your own levelpacks.

2.2 Converting 0.92 Levelpacks

With the changes of the levelpack index format, converting old levelpacks is necessary. Although the main work is done automatically just by starting Enigma, a few special cases remain that need manual preparation. Further on, after the autoconversion, some cleanup may be useful.

If you formerly maintained your levelpacks within the Enigma system levels directory, you should now copy your own levelpacks from the old Enigma version to the '`user path`' subdir '`levels`' (see Section 1.1 [Locating Resources], page 1). The '`user path`' exists on all systems, and since Enigma 1.00 will never write to the system levels directory, it will perform updates and conversions only on the '`user path`'. If you registered your levelpacks on the system levels directory within the '`index.lua`' file, you need to copy these registration lines to the '`index_user.lua`' file, which you should store on your '`user path`'.

If you maintained several of your own levelpacks, Enigma 0.92 allowed you to keep them in several subdirectories of the '`levels`' directory. However, since it also allowed you to keep all level files and different indices in the '`levels`' directory itself, you will run into trouble with the auto conversion, because Enigma 1.00 allows only one levelpack with attached level files per directory. In this case, we recommend a step-by-step conversion: in every step, provide only one old index for conversion. Enigma will convert this index to a new '`index.xml`'. Move this new index, together with all levels, to a subdirectory and convert the next levelpack.

A last special case occurs if you had an old index stored in '`levels`' that referenced level files in different subdirectories of '`levels`'. Since Enigma 0.92 did not have a concept of cross-references, and Enigma 1.00 requires that you store all level files attached to a levelpack in a single subdirectory, the conversion algorithm needs to guess the correct subdirectory. It simply takes the subdirectory of the first level. If this does not fit, you may need to clean up your 0.92 levelpack prior to conversion.

Enigma should convert all other standard levelpacks without problems. It only performs the conversion once. As soon as the new '`index.xml`' exists, only this index is used. Thus, after a careful check, you may remove the old '`index.txt`'. We recommend keeping a backup of the old index until you have completely switched to Enigma 1.00.

If you used a levelpack of your own in the zip format, you will find a subdirectory named with the base name of the zip archive in your user '`levels`' directory. Enigma stores the converted '`index.xml`' within this directory. You may want to exchange the old '`index.txt`' in the zip with the new index. Afterwards you can delete the subdirectory, since Enigma will load the index directly from the zip archive.

After converting your levelpacks, we strongly recommend that you update your own levels to the new XML format, as described in Chapter 3 [Level Basics], page 21.

2.3 Zip Levelpacks

Besides the classic levelpack format of a subdirectory of '`levels`' with an '`index.xml`' and several level files, Enigma 1.00 provides a compatible zip archive format. This zip allows you to reduce resources and to ease distribution of levelpacks.

The compatibility is 100%. If you have a classic subdirectory levelpack, you can simply zip the complete subdirectory and name the zip with the name of the subdirectory, plus the standard '`.zip`' suffix. Now you can completely remove the subdirectory; Enigma autodetects the levelpack and it is fully playable. Even cross-references into this levelpack will not be broken!

On the other hand, Enigma allows you to expand every zip levelpack to a subdirectory with index and level files. Again, everything runs and no cross-references are broken.

If you keep both, the files contained in the subdirectory precede files in the zip archive. Thus, Enigma stores updates of single files in subdirectories in parallel to existing zip archives.

2.4 Grouping and Sorting Levelpacks

As the number of levelpacks increased, it became necessary to sort and group the levelpacks in the menu. We tried to provide a useful set of default groups and default assignment of the distributed levelpacks to these groups:

- **Enigma** - levels that are written just for Enigma
- **Déjà-vu** - levels that you may have seen before
- **Sokoban**
- **Facets** - special sortings and views of the levels above

- **User** - personal levels and levelpacks like History, Autofolder generated by the system for the user.
- **Development** - templates and unfinished levels from the Enigma Team
- **All Packs**

Still, this is just a proposal. You are free to rename the groups, add new groups and change the assignments of the levelpacks. As in other parts of Enigma, you can right or control click on the group and levelpack buttons.

The group configuration menu allows you to rename and reposition a group. You can choose any name that is not a duplicate, that is not enclosed in square brackets and differs from '`Every Group`'. Note that you may not be able to enter as many characters as you are used to. Sorry for this inconvenience.

The levelpack configuration menu allows you to assign a pack to a group. The group list contains two special entries: '`[Every Group]`' and another name enclosed in square brackets. Selecting the first pseudogroup displays the levelpack in every group. This is the default assignment of the '`Startup Levels`' group. The second square bracket-enclosed name is the default group of the levelpack itself. It is a hint for you and allows you to reassign a levelpack to the default group even if meanwhile you have deleted the group.

2.5 Creating New Levelpacks

To create a new levelpack, you simply select the group to which you want to add the new pack. This is most likely the '`User`' group. Right or ctrl click on the group and simply click on the '`New Levelpack`' button. Enigma will call the levelpack configuration menu, which allows you to enter all the important data for the creation of a levelpack.

First you should enter a name for the levelpack. You are limited to characters that can be used for filenames, too. You may use alphanumerical characters A-Z, a-z, 0-9 and space, underscore and hyphen. Note that you may rename the pack later for a better or more suitable display name (see Section 2.6 [Modifying and Deleting Levelpacks], page 19).

Later, you should decide whether you want a levelpack that can contain level sources or just a crossreference levelpack. The first one is useful for storing your own self-written levels or levels that you download from the internet. You may use the crossreference levelpacks for your favorite collections, where you simply reference existing levels of other levelpacks with your own personal sorting. You set the selected type with the '`Level types`' button, which uses symbols for references and carbon copies.

The '`Default Location`' is a number that determines the sorting location within levelpack groups, if you have not resorted the levelpack manually (see Section 2.4 [Grouping and Sorting Levelpacks], page 17). This default value is relevant only if you distribute your levelpack and want to ensure that the users will find your levelpack at a proper location. The value given after creating a new levelpack should work well in most circumstances.

You may declare yourself as owner or creator of the levelpack. This is just a string for identification purposes.

Finally, when you have completed the configuration, you can create the levelpack by clicking '`OK`'. Enigma will create the levelpack on your '`userpath`' (see Section 1.1 [Locating Resources], page 1).

If you decide not to create a new levelpack, just click '`Undo`'. Enigma will not create or change anything in this case.

If you want to set up the new levelpack immediately, you can click directly on '`Compose Pack`'. Enigma will create the levelpack, and you can use the composer to fill it with levels.

2.6 Modifying and Deleting Levelpacks

To modify a levelpack, right or ctrl click on its button in the levelpack menu. You will see the metadata for all levelpacks. However, an '`Edit Metadata`' button will appear only for your own levelpacks, which Enigma stores on your '`userpath`'. Clicking on it allows you to edit the metadata.

Renaming the levelpack is possible, but Enigma will not change the filenames anymore. It will use the new name as the logical levelpack name that shows up in Enigma.

Other attributes that you can modify include the '`Default Location`' and the '`Owner`'.

Note that changing the levelpack type later is not possible. You must create a new levelpack of the proper type and copy the levels by using Section 2.7 [Composing Levelpacks], page 19.

We do not provide a levelpack deletion function to avoid unintended loss of levelsources. Still, the deletion of a levelpack is as simple as deleting the complete levelpack directory on your '`userpath`'. For crossreference levelpacks, you simply need to delete the index XML file on the '`levels/cross`' subdirectory of your '`userpath`'.

2.7 Composing Levelpacks

You can change the levels of a levelpack by using the levelpack composer. You call it by right or ctrl clicking on the levelpack button in the levelpack menu, then clicking on the '`Compose Pack`' button in the levelpack configuration menu.

The composer looks similar to the levelmenu, but it provides other functionality. Enigma lists all commands in the F1 help menu. First, if you compose your own levelpacks, you may note that the levels are bordered red. This is a warning, since you can modify these levelpacks. System levelpacks (the distributed Enigma levelpacks) will border the levels in gray, since you can use the composer only for copying levels to the clipboard.

The clipboard allows you to select levels in one or several levelpacks and to insert these levels as reference or as copy to your own levelpacks. First, clear the clipboard by '`Shift delete`'. Then select any levels you want from within the composer levels, and add them by '`Shift click`'; or use '`F6`' to add all levels from the current levelpack to the clipboard. They will appear in the upper text lines in the composer. Return to the levelpack where you want to add the levels. Select the level behind which you want to add the levels. Use '`F8`' to insert the levels of the clipboard as references. If you edit a levelpack that can take level copies, you may use '`F9`' to insert the levels of the clipboard as file copies.

As soon as you modify the levelpack, a small red triangle in the upper left corner signals the modification. Leaving the composer via the '`OK`' button finalizes all changes. Leaving the composer via the'`Undo`' button reverts all changes.

Besides adding levels, you can delete levels by using the '`delete`' button. Note that Enigma will delete the level files themselves if you delete a level that is not just a reference.

Be careful with all levels that have the document icon on their preview. You can revert deletions with the '`Undo`' button.

You can resort all levels with the '`alt left arrow`' and '`alt right arrow`'. The new sorting appears immediately, and you can save it by using the '`OK`' button.

You can use the '`F5`' button to update the index from the levels. This is very useful if you edit levels yourself. The levelpack will notice changes in title, revision, easy mode support etc. Enigma updates all levels of the levelpack at once.

By using the Auto levelpack and the composer, you can set up levelpacks of your own levels, as follows: Create a new levelpack, add the level files to the '`auto`' folder, restart Enigma, add the levels from the '`auto`' folder to the clipboard, use the composer to insert the levelpack to your levelpack as a copy, and delete the unused level file copies from the '`auto`' folder.

Outside the composer, you can use '`F6`' in a normal level menu as well. This way you can swiftly create level packs from search results: Make sure the clipboard is empty, enter your search criteria in the search menu, start the search, press '`F6`', create a new level pack, go to its composer, and press '`F8`'.

3 Level Basics

Now that you have played some levels of Enigma, you may have noticed that Enigma is quite a dynamic game with versatile levels. Thus, it is not astonishing that it is impossible to describe such levels with a static approach of a simple object map like Sokoban. Some levels, like mazes, generate their layout and look different each time you play them. Other levels provide a dynamic behavior during the play; i.e., switches may open doors only in certain circumstances. To comply with these demands, we have integrated the powerful lightweight C extension language Lua (`http://www.lua.org`) as of version 5.1.4 into Enigma.

Up to Enigma 0.92, two different level formats did exist. One was a XML-like format, primarily designed for external level editor programs. Because its static object map description part was inconvenient for manual editing, many authors never used it. The second format was plain Lua code that used an interface of Enigma Lua functions to add objects and callback functions. Nearly all authors used this second format, but it had a small drawback: you could store metadata for the level (like the author name, license info, and last but not least, the level name itself) only as unformatted Lua comments, and you had to reinsert it manually into the level-package indices.

With the post-0.92 XMLification of Enigma, we achieved full XML support by integrating Apache Xerces, and were wondering how to get rid of the old level format drawbacks and how to add some compelling new features:

- a single format with optional parts - use only those parts you need
- no major changes or any limitations for Lua level authors
- keep all author-supplied metadata in the level
- enable plug & play for users - copy the level from the author and play it without manual index edition
- support of various encodings, such as US-ASCII, UTF-8, UTF-16, Windows-1252
- internationalization of levels - allow authors to add strings in their native language and supply translators with all translatable level strings and comments from the authors' how-to-translate.
- add a release and dependency management for levels and libraries
- add level update and upgrade support for levels and libraries
- substitute the old XML format with a versatile editor interface
- keep the format open to future extensions

Let us have a first view on complete simple '`Hello World`' level in the new format:

```
<?xml version="1.0" encoding="UTF-8" standalone="no" ?>
<el:level xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation="htt
game.org/schema/level/1 level.xsd" xmlns:el="http://enigma-game.org/schema/level/1">
  <el:protected >
    <el:info el:type="level">
      <el:identity el:title="Demo Simple" el:id="20060210ral001"/>
      <el:version el:score="1" el:release="1" el:revision="2" el:status="stable"/>
      <el:author  el:name="Ronald Lamprecht"/>
      <el:copyright>Copyright © 2006,2009 Ronald Lamprecht</el:copyright>
      <el:license el:type="GPL v2.0 or above" el:open="true"/>
      <el:compatibility el:enigma="1.10"/>
      <el:modes el:easy="false" el:single="true" el:network="false"/>
      <el:score el:easy="-" el:difficult="-"/>
    </el:info>
    <el:luamain><![CDATA[
ti[" "] = {"fl_lawn_b"}
ti["#"] = {"st_box"}
ti["o"] = {"st_oxyd"}
ti["@"] = {"#ac_marble"}

wo(ti, " ", {
    "####################",
    "#                  #",
    "#  o      @     o  #",
    "#                  #",
    "####################",
})
    ]]></el:luamain>
    <el:i18n/>
  </el:protected>
</el:level>
```

You may notice that the XML portion contains all the metadata that the level author is accustomed to supplying with a level. The XML part is like a formula that you can copy from a template and fill out.

The Lua code is embedded in the XML. The only limitation to the Lua portion is that it reserves '`]]>`' for the end mark, and you would have to substitute it with '`]] >`'. No further restrictions.

Since the example above includes all mandatory XML parts, we should achieve our aim to avoid major changes for Lua level authors.

You can find the example above in the '`Exp`' levelpack grouped in '`Development`'. The source code is located on the system path subdirectory '`levels/enigma_experimental`' (see Section 1.1 [Locating Resources], page 1).

If you make your first coding experiments on a copy of this level, either add your copy to the auto folder (see Section 2.1 [Getting Started with Levelpacks], page 15), or use it as an argument on the command line (see Section 1.2 [Startup Switches], page 2).

Of course we must look at the details of the format and explain the optional parts:

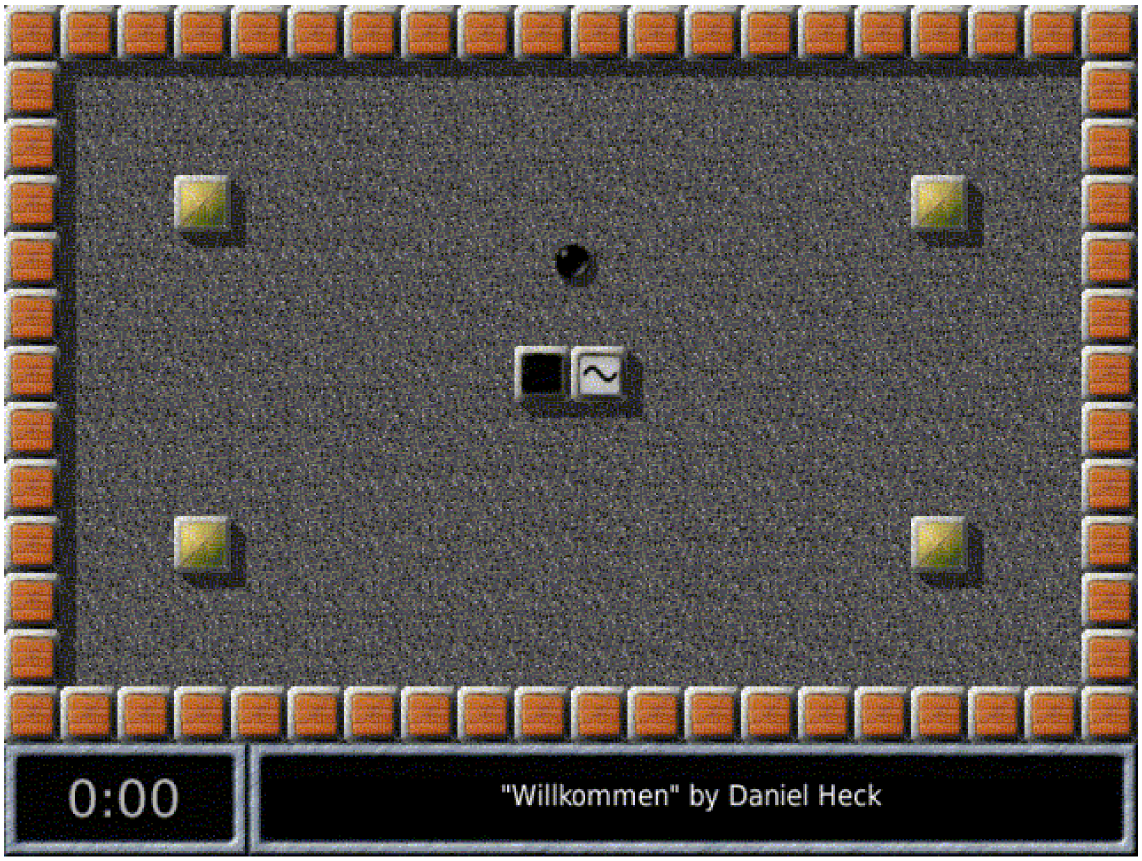
3.1 Getting Started with Levels

Most likely you are keen on understanding the basic principles of placing objects in a level. Here is a very simple level description that can also serve as a starting-point for new landscapes. (In fact, this is the first welcome level in levelpack Enigma I, so you can try it out right away.)

```
ti[" "] = {"fl_gravel"}
ti["#"] = {"st_box"}
```

```
   ti["O"] = {"st_oxyd"}
   if wo["IsDifficult"] then
       ti["Q"] = {"st_quake", name="quake"}
       ti["T"] = {"st_timer", interval=10.0, target="quake"}
   else
       ti["Q"] = ti[" "]
       ti["T"] = ti[" "]
   end
   ti["@"] = {"ac_marble_black", 0.0, 0.5}

   wo(ti, " ", {
"####################",
"#                  #",
"#                  #",
"#  O            O  #",
"#         @        #",
"#                  #",
"#        QT        #",
"#                  #",
"#                  #",
"#  O            O  #",
"#                  #",
"#                  #",
"####################"})
```

The resulting level looks like this inside the game:



Let's now turn to a line-by-line analysis of this program:

```
 1     ti[" "] = {"fl_gravel"}
 2     ti["#"] = {"st_box"}
 3     ti["O"] = {"st_oxyd"}
```

First we declare some keys for objects we like to use in our level map. We just add each key to our *ti* tiles repository and assign an object tile description that consists of the object kind name in these simple cases. The two character prefix of the kind name shows us the basic object type like floor, item, stone, actor, etc.

```
 4     if wo["IsDifficult"] then
 5         ti["Q"] = {"st_quake", name="quake"}
 6         ti["T"] = {"st_timer", interval=10.0, target="quake"}
 7     else
 8         ti["Q"] = ti[" "]
 9         ti["T"] = ti[" "]
10     end
```

The welcome level provides two modes, the regular difficult one and an easy one. As the regular difficult one differs just in two additional stones we add two mode specific tile declarations.

In the difficult mode we assign two stone definitions. Each provides the stone kind and additional attributes. The ‘`st_quake`’ is the stone that closes oxyd stones when being hit or toggled. We just name it, to be able to reference it later on. The second stone is a timer that should get active every 10 seconds and should send a toggle message to its target, our oxyd closing ‘`st_quake`’. As we did name this stone we can reference it here as target by its name.

```
ti["@"] = {"ac_marble_black", 0.0, 0.5}
```

Now we just need to declare our actor. It is a black marble that should not be placed at the left upper corner of a grid but in the mid of the left border of a tile grid. Actually we just want to center it within the level. As a one screen sized level has the extension of 20 x 13 we need the offsets given above.

```
wo(ti, " ", {
    "####################",
    "#                  #",
    "#                  #",
    "#  O            O  #",
    "#         @        #",
    "#                  #",
    "#        QT        #",
    "#                  #",
    "#                  #",
    "#  O            O  #",
    "#                  #",
    "#                  #",
    "####################"})
```

Now we can create the world simply by providing a map. We just need to call ‘`wo`’, our world handle, provide it our tile resolver, the key of the default floor and a map of tile keys.

You will find all conceptional background information in chapter Chapter 4 [Enigma Paradigm], page 46, and more examples and syntax information in chapter Chapter 5 [Lua API], page 63. But first you should take the time to get aware of the XML based level metadata.

3.2 XML Level structure

Let us start with a complete overview of all existing top XML element nodes. The following level skeleton contains optional elements that are beyond level basics. We include these elements for completeness:

```
<?xml version="1.0" encoding="UTF-8" standalone="no" ?>
<el:level xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation="htt
game.org/schema/level/1 level.xsd http://enigma-game.org/schema/editor ed-
itor.xsd" xmlns:el="http://enigma-game.org/schema/level/1" xmlns:ee="http://enigma-
game.org/schema/editor">
  <el:protected>
    <el:info el:type="level">
      <!-- required elements omitted -->
    </el:info>
```

```
        <el:elements/>
        <el:luamain><![CDATA[
        ]]></el:luamain>
        <ee:editor/>
        <el:i18n/>
      </el:protected>
      <el:public>
        <el:i18n/>
        <el:upgrade/>
      </el:public>
    </el:level>
```

The first line is the XML declaration. It is fixed besides the encoding specification. Enigma supports on all platforms, at least '`US-ASCII`', '`UTF-8`', '`UTF-16`', '`ISO-8859-1`', '`windows-1252`'. Enter your encoding and make sure that your editor saves the level in this encoding. On some editors, you can start in ASCII mode, copy the level skeleton with a different encoding declaration, like UTF-8, save the level still in ASCII mode and reopen the file. The editor may then detect the XML declaration and switch automatically to the given encoding. Note that unless you enter international strings in the level, you do not have to bother with the encoding at all. You can choose UTF-8 in this case.

Some additional remarks for XML newbies: The XML markup tags are quite similar to HTML. But XML requires a corresponding end tag '`</element>`' for each start tag '`<element>`'. For elements that have only attributes and no content, you can and should use the alternative empty element notation '`<element/>`'. Note that when we define an element as empty or state that no content is allowed, not a single whitespace, not even a linebreak is allowed between start and end tag. Use the empty element notation to avoid mistakes.

We use a pretty printing format with an indentation of 2. Each element starts on a separate line. Elements with text content have the end tag on the same line. Only elements with subelements have the end tag on a separate line with the same indentation.

This format is not mandatory. You can even insert linebreaks in text contents, within the marks, and even within attribute values. But note: The basic rule is that each linebreak will be substituted by a space during the XML parsing. Take this space into account to avoid mistakes, or simply live with the long lines.

A namespace identifier prefixes all tag names and attribute names. We use '`el`' as an abbreviation for Enigma levels. All tag names you can manually edit use this prefix.

Finally, a short comment on the XML reserved characters, '`&`' and '`<`'. These two characters are reserved as tag and entity starting characters. If you need them in text contents or in attribute values, you must substitute them by the entity sequences '`&amp;`' and '`&lt;`'. Additionally, you must enclose attribute values with either '`"`' or '`'`'. Of course, you must substitute the enclosing character used in attribute values, too. Use '`&quot`' and '`&apos`'.

Elements:

/level, *required, single occurrence*

This is the root node. Only one instance of this node occurs per file. Like the first XML declaration line, this second line is quite fixed. There are two versions. The simple 3-attribute version, as used in the first example, and only level editor programs use the 4-attribute version as above. For manual level editing, just copy the simple version as the second line to your level file.

Attributes:

xmlns:xsi, *required, contents fixed*
: Namespace definition for the schema. The contents are fixed to “http://www.w3.org/2001/XMLSchema-instance”. The attribute tag ‘`xsi`’ must match the prefix of the next attribute tag, and is standard.

xsi:schemaLocation, *required, contents fixed*
: Location of the schemas used. The contents are the fixed Enigma level namespace, followed by the schema location URL. Level editor programs will add their namespace and their schema location URL, as in the second example above.

xmlns:el, *required, contents fixed*
: Namespace definition for “Enigma level”. We use ‘`el`’ as the namespace prefix for all level element and attribute tags, as standard. The prefix used can be arbitrary, but must match this attributes tag. The contents of the attribute is fixed to the Enigma level namespace.

xmlns:ee, *optional*
: Only level editor programs use this last namespace definition. For example, we declared ‘`ee`’ as the namespace prefix for all editor element and attribute tags. The prefix you use can be arbitrary, but must match this attributes tag. The contents of the attribute are the editor’s namespace.

/level/protected, *required, single occurrence*
: The protected node section contains all level data that derive from the author and should not be modified by anyone else.

/level/protected/info, *required, single occurrence*
: The info node section contains all level metadata. It is mandatory and described in detail at section Section 3.3 [Info metadata], page 28.

/level/protected/elements, *optional, single occurrence*
: The elements node section is optional. It contains level description parts that are given in a data-driven manner. Though the driving force is the support for level editor programs, a level author may use any parts of this section he or she likes.

/level/protected/luamain, *optional, single occurrence*
: The luamain node section is the part to insert manually Lua level descriptions. It is described in detail at section Section 3.4 [LUA code], page 38.

/level/protected/editor, *optional, single occurrence*
: The editor node section is an open extension area for level editor programs. They can add any additional information in this section that they need. Enigma simply ignores this node section.

/level/protected/i18n, *required, single occurrence*
: The i18n node section contains English strings, native translations and comments supplied by the author for the translators. This node section is mandatory and described in detail at section Section 3.5 [Internationalization (i18n)], page 39.

/level/public, *optional, single occurrence*
: This public node section is an optional extension to the protected part. It contains information that the author has not validated and may even be added after the last author's review.

/level/public/i18n, *optional, single occurrence*
: This public i18n section contains further translations supplied for the level. They may derive from the author or other sources. The translators will validate these translations, and they continue in use if the translators do not supply corrected versions. See Section 3.5 [Internationalization (i18n)], page 39.

/level/public/upgrade, *optional, single occurrence*
: This upgrade node is part of the Section 3.7 [Update and Upgrade], page 42, system.

3.3 Info metadata

The Info node contains all author-supplied metadata for the level. This is the source of these data. All other parts of Enigma, such as level indices, simply contain copies that will be automatically updated to the level's original data.

Let us look at all supported subnodes of info with typically used attributes:

```
<el:info el:type="level">
  <el:identity el:title="Demo I18N" el:subtitle="Translate or let it be trans-
lated" el:id="20060211ral002"/>
  <el:version el:score="1" el:release="1" el:revision="0" el:status="experimental"/>
  <el:author  el:name="Ronald Lamprecht" el:email="ral@users.berlios.de"/>
  <el:copyright>Copyright © 2006 Ronald Lamprecht</el:copyright>
  <el:license el:type="GPL v2.0 or above" el:open="true"/>
  <el:compatibility el:enigma="0.92"/>
  <el:modes el:easy="false" el:single="true" el:network="false"/>
  <el:comments/>
  <el:update el:url="http://..."/>
  <el:upgrade el:url="http://..." el:release="2"/>
  <el:score el:easy="-" el:difficult="-"/>
</el:info>
```

Attributes:

type, *required*, values = `"level"`, `"library"`, `"multilevel"`
: You may use the schema for single Enigma levels, libraries that contain level description parts for reuse, and descriptions for multiple levels at once.
: '`level`' are all single level descriptions. It does not matter if you edit them manually or with a level editor program, or which description elements you use.

'`library`' are level description parts that may be included in levels. Section 3.8 [Library Files], page 43, consist simply of Lua code in the luamain node. Libraries may make use of nearly all nodes besides the '`/level/protected/info/score`' and '`/level/*/i18n`', which both must be provided, but will not be evaluated. Libraries are included in levels via the dependency node-element. See Section 3.3.6 [<compatibility>], page 33.

'`multilevel`' are descriptions for multiple levels at once. The main purpose is to support foreign game level formats, like the Sokoban level format, which usually describes a whole set of level maps in a single file (see Section 3.9 [Multilevel Files], page 45).

quantity, *optional*
: The number of levels contained in a multilevel file (see Section 3.9 [Multilevel Files], page 45).

Contents - Elements:

identity, *required*
: The title, subtitle and the main level identification string. See Section 3.3.1 [<identity>], page 30.

version, *required*
: All aspects of the level Section 3.3.2 [<version>], page 30.

author, *required*
: All information provided about the author him- or herself. See Section 3.3.3 [<author>], page 32.

copyright, *required*
: The Section 3.3.4 [<copyright>], page 32, message for the level.

license, *required*
: Information about the Section 3.3.5 [<license>], page 33, conditions.

compatibility, *required*
: All information about Section 3.3.6 [<compatibility>], page 33, to Enigma releases, dependencies from libraries, external data and the editor program that generated the level.

modes, *required*
: The Section 3.3.7 [<modes>], page 35, that the level supports, such as difficulty, network and control.

comments, *optional*
: Optional comments, such as credits, dedication and code comments. See Section 3.3.8 [<comments>], page 36.

update, *optional*
: Section 3.7 [Update and Upgrade], page 42,

upgrade, *optional*
: Section 3.7 [Update and Upgrade], page 42,

score, *required*
: The author's own Section 3.3.9 [<score>], page 37, of this level.

3.3.1 <identity>

The '**identity**' element is required, since it provides the information for human and system identification of the level.

```
<el:identity el:title="Demo I18N" el:subtitle="Translate or let it be trans-
lated" el:id="20060211ral002"/>
```

Attributes:

title, *required*
: The English title of the level. The string can contain arbitrary characters that are displayable by Enigma's font and XML conformant. Just in case of Section 3.9 [Multilevel Files], page 45, a trailing hash sign has a special meaning. Anyway please make sure that the title is not too long, since Enigma will use it on the level selection menu. Translations of the title can be provided in the Section 3.5 [Internationalization (i18n)], page 39, sections.

subtitle, *optional*
: An optional English subtitle. Used for title parts that are too long for the main title, or for a short first hint. Enigma displays the subtitle on the level info page and on the start of the level. Translations of the subtitle can be provided in the Section 3.5 [Internationalization (i18n)], page 39, sections.

id, *required*
: This is the central system identification string of the level that remains valid for all time, independent of upcoming release updates. The id string should not contain spaces, braces and wildcard characters, that means no character out of '`*? ()[]{}`'. Enigma's main demand on the id is that it is unique among all levels created by all authors around the world and that it does not end on a closing square bracket.

  Since you can edit levels with any text editor or different special Enigma level editors, there is no control about the uniqueness. Thus, we have to provide a simple convention to avoid any possible id clashes:

  YYYYMMDDuserNNN

  Where '`YYYY`','`MM`','`DD`' is the date of the creation of the first experimental version, '`user`' stands for a user-specific name and '`NNN`' for a random number. For example, my level called '`Houdini`' has the id '`20060816ral719`'. Of course all levels created on the same day have to differ in the random number part. The id is an Enigma level system id, and is never exposed to users.

  For backward compatibility, legacy levels keep their former filename as the new level id, and do not fit in the name schema given above. Still, that does not harm since the only requirement is the uniqueness.

Contents:

The element itself is empty - no content is allowed.

3.3.2 <version>

This element provides the versioning information for the system.

```
<el:version el:score="1" el:release="1" el:revision="0" el:status="experimental"/>
```

Attributes:

score, *required*

The score version is given as a positive integer number. New levels start with score version “1”. New level versions need to increase the score version number if the level modifications cause different solutions with incomparable score values. Of course, level authors should be very restrictive with such modifications.

During the development of a level, you should use the attribute ‘**status**’ to mark a level as not released. When the author changes the ‘**status**’ to ‘`released`’, he has to check scoring compatibility and increase the score version if necessary.

This attribute is the logical equivalence to the Enigma 0.92 ‘`index.txt`’ attribute ‘`revision`’.

release, *required*

The technical release version is given as a positive integer number. New levels start with release version “1”. You must increase the release version number if the level modifications cause either technical incompatibilities with previous Enigma releases, or the scoring version has been increased.

The primary cause for technical incompatibilities should be the compensation of Enigma engine changes. Since such compensations will not run on the old Enigma version, the level versions must be distinguished by a different release number.

In both cases, technical and scoring incompatibilities, the level file name must be changed, too. This is necessary since different Enigma versions may be installed on some systems at the same time. They have the need for both level versions at the same time. Internet servers providing Enigma levels need to offer the different level release at the same time, too.

To enable people to assign different level release files to a level itself, we strongly recommend the name convention for levels *AuthoridentifierLevelnumber_Releasenumber.Suffix*, where the levelnumber is at least 2 digits; for example, ‘`ral01_2.xml`’

revision, *required*

The revision number is a simple, ever-increasing version number. Every published version of the level should have a new revision number. The revision number is independent from the scoring and release version number.

If Enigma finds two levelfiles in its data search paths with identical filenames, id, score and release version, it will load the one with the higher revision number. This feature guarantees that an older level revision stored on the user’s home level directory cannot supersede a new revision of a level distributed with a new Enigma release. Online updates will check the level revision numbers, too.

Although the revision evaluates to a number, the attribute can take a second string format as the literal keyword ‘`$Revision$`’. This Subversion (`http://subversion.tigris.org/`) format allows level authors to let their Subversion repository automatically insert the level revision number. They must simply set ‘`svn propset svn:keywords "Revision" level.xml`’ at their repository for every level file. Since the Subversion revision number is ever-increasing, it fulfills our criteria. Note that Enigma does not require that revision numbers be consecutive.

status, *required*, values = “released”, “stable”, “test”, “experimental”
: This attribute describes the quality of the level during development. Enigma uses the status to protect the score database from being spoiled by unplanned solution scores. It will record scores only for levels marked as ‘`released`’.

  As a level author, if you start to change a released level, you should first change the status back to ‘`experimental`’. Then make your changes and test the level. When you are definitively sure that you did not introduce any spoilers, you can release the level again with a new revision and perhaps a new release or score version number.

Contents:

The element itself is empty - no content is allowed.

3.3.3 <author>

The information about the author him/herself. Enigma requires the author element itself, but all attributes are optional to allow an author to be anonymous. Please remember that level administrators and translators may need to contact you as the author. So please provide a way for them to contact you.

The author element node may look like:

```
<el:author  el:name="Ronald Lamprecht" el:email="ral@users.berlios.de" el:homepage="ht
```

Attributes:

name, *optional*, default = “anonymous”
: The author’s name as it will be displayed on the level info page and on the start of the level. The name defaults to ‘`anonymous`’.

email, *optional*
: The author’s email address or a newsgroup or forum he monitors. In general, this is a hint as to how to communicate with him or her. The value will simply be displayed as a string on the level info page.

homepage, *optional*
: An address for the author or where the author publishes additional Enigma levels. The value will simply be displayed as a string on the level info page.

Contents:

The element itself is empty; no content is allowed.

3.3.4 <copyright>

The standardized location for the author’s copyright message:

```
<el:copyright>Copyright © 2006 Ronald Lamprecht</el:copyright>
```

Attributes:

none

Contents:

The author’s copyright notice.

3.3.5 <license>

Of course, every author is free to choose the license conditions for his/her levels. However, the author must state the conditions. Thus, this node element and its attributes are required:

```
<el:license el:type="GPL v2.0 or above" el:open="true"/>
```

Attributes:

type, *required*
: A short license identifier of the license type, with an optional link address to the license text or the string '`special`', if the author supplies his/her own license as the content of this element.

open, *required*
: A boolean statement, whether the chosen license fulfills the criteria of the Open Source Initiative (OSI) (`http://www.opensource.org/`). Please note that a value of '`false`' may prevent your level from being distributed with Enigma.

Contents:

You may add a complete license text as the contents of this element. Please use the type attribute to identify the level.

3.3.6 <compatibility>

```
<el:compatibility el:enigma="0.92" el:engine="enigma">
  <el:dependency el:path="lib/natmaze" el:id="lib/natmaze" el:release="1" el:preload="tru
  <el:externaldata el:path="./extfile" el:url="http://anywhere.xxx/mypage/extdata.xml"/>
  <el:editor el:name="none" el:version=""/>
</el:compatibility>
```

Attributes:

enigma, *required*
: The minimal Enigma release number required for compatibility.

engine, *optional*, values = "enigma", "oxyd1", "per.oxyd", "oxyd.extra", "oxyd.magnum"; default = "enigma"
: The required engine compatibility mode that influences the behavior of various objects. This attribute is evaluated only for levels. Libraries ignore this attribute.

Contents - Elements:

The compatibility element itself contains only subelements as content.

dependency, *optional, multiple occurrence*
: You can use this element to specify any Enigma-Lua library this level depends on. You can specify several libraries by multiple occurrence of this element. If you configure a library to be preloaded, the engine will load it before it loads or executes any level Lua code. The load sequence of several libraries conforms strictly to the sequence of their dependencies elements.

Attributes:

path, *required*

The resource path of the library without its suffix or any release extension. Enigma stores most libraries in the '`lib`' subdirectory of its '`levels`' directory, in most cases the resource path will be like the one in the example above: '`lib/ant`'. This is the valid path for the library file that may be either '`levels/lib/ant.xml`' or '`levels/lib/ant.lua`' or '`levels/lib/ant_1.xml`'.

However, libraries can also be totally level pack-specific. In this case, you may use a relative resource path, such as '`./mylib`' and store the library in the level pack directory itself.

id, *required*

The version independent id of the library, as specified in the library metadata. Enigma will check it on load of the library to avoid problems, and may use it with the release number to detect relocated libraries.

release, *required*

Although different release versions of libraries must have different filenames, we require to specify the library version. Enigma will check it on load of the library to avoid problems, and may use it with the release number to detect relocated libraries.

preload, *required*

A boolean statement that specifies whether the library should be preloaded. If the library is not preloaded, you can still load it via Lua code statements. Yet even those libraries must be declared since Enigma will check them on conformance. You should always preload your libraries if you make use of the '`elements`' section.

url, *optional*

This optional attribute allows you to specify a backup address for the library. This will be useful for using new libraries that are not yet distributed with the system.

For the development and test phase of new libraries themselves, a developer can hand out test levels with an empty '`library`' resource path attribute. The test levels will load the newest library version as published at the given url.

Contents:

none.

externaldata, *optional, multiple occurrence*

You can use this element to specify any external text data file this level depends on. You can specify several files by multiple occurrences of this element. Files declared can be read via the Lua interface.

This feature should support levels that simulate foreign games like Sokoban within Enigma. Due to copyrights and license conditions, the inclusion of such data within a level or even the distribution with Enigma may not be possible. However, distributing or downloading the data in the original unmodified format may be legal.

Attributes:

path, *required*
: The resource path of the external data file without its suffix '`.txt`'. The path has to be either of the format `"./name"` for an external data file that is locally stored in the same folder as the level file, or will be saved at this position when it gets downloaded. Or the path can be of the format `"externaldata/name"` for shared external data files, that are referenced by multiple level files stored at different folders. The external data file will be locally stored or gets saved in the folder `"levels/externaldata"`. In any case the local name of the external data file will have the suffix '`.txt`' to mark it readable but not executable for the local operating system.

url, *optional*
: This optional attribute allows you to specify an internet download address for the external data file. On first access a missing external data file will be downloaded and a copy will be stored locally for further access.

Contents:

none.

editor, *optional, single occurrence*
: Special level editor programs use this element to store information about themselves.

Attributes:

name, *required*
: The name of the level editor.

version, *required*
: A version number of the editor, given as a string. .

Contents:

none

Contents:

none

3.3.7 <modes>

The modes element allows the author to declare the supported and the default modes of his level. Enigma's engine checks that the level is used in supported modes.

```
<el:modes el:easy="false" el:single="true" el:network="false" el:control="force" el:scoreu
```

Attributes:

easy, *required*, values = "true", "false"
: If a level provides a second easy-difficulty mode, set this attribute to '`true`'. If only a one difficulty mode is supported, set this attribute to '`false`'.

single, *required*, values = “true”, “false”
: If a level provides a single player game as it is standard, set this attribute to ‘`true`’. Set this attribute to ‘`false`’ only if the level is a 2-player-network game.

network, *required*, values = “true”, “false”
: If a level provides a 2-player-network game, set this attribute to ‘`true`’. If not, set this attribute to ‘`false`’.

control, *optional*, values = “force”, “balance”, “key”, “other”; default = “force”
: This attribute defines the standard control mode of the level. You can play a level by using the mouse to generate forces on the marbles, since it is the standard and was the only way up to Enigma 0.92. Or you can play a level using the mouse, or other input devices to balance the level-world with the marbles. Or you may use the keyboard with its cursor keys to move the actor like in classic Sokoban games.

  Although the user has always the last choice to define the input method he/she currently wants to use, the author must define the standard control-mode that the scoring system uses. Enigma will save and evaluate only scores achieved in the defined control mode for high score lists.

scoreunit, *optional*, values = “duration”, “number”; default = “duration”
: This attribute defines the evaluation and display mode of score values. By the default ‘`duration`’, the score is interpreted as level solution time and displayed in a **MM:SS** format. The ‘`number`’ mode displays scores as plain numbers and lower numbers will be evaluated as better scores. This mode is appropriate for counting pushes and moves.

scoretarget, *optional*, values = “time”, “pushes”, “moves”, *; default = “time”
: The score target triggers the measuring of score values. ‘`time`’ will take the solution time, ‘`pushes`’ counts the pushes of stones, ‘`moves`’ counts the moves of the actor. Any other value will call a Lua function for score values. The target is used as a short title for the score in user interface displays.

Contents:

none

3.3.8 <comments>

The optional comments node allows the author to add a few comments and to determine how they should be processed. Please note that internationalization support will not translate comments.

```
<el:comments>
    <el:credits el:showinfo="true" el:showstart="false">Thanks to the author of my fa-
vorite libs</el:credits>
    <el:dedication el:showinfo="true" el:showstart="false">To a honorable or a beloved pe
    <el:code>some important general notes</el:code>
</el:comments>
```

Attributes: none

Contents - Elements:

The comments element itself contains only subelements as content.

credits, *optional, single occurrence*
The place to honor people who helped to make your level run.

Attributes:

showinfo, *optional*, default = "false"
A value of '`true`' will display the message on the level info page

showstart, *optional*, default = "false"
A value of '`true`' will display the message on startup of the level. Please use this feature only in rare cases.

Contents:

The credits message itself. It may be broken into several lines. Whitespace will be collapsed before display.

dedication, *optional, single occurrence*
The place to dedicate the level to a honorable or a beloved person. Please use this place instead of adding document-items within the level.

Attributes:

showinfo, *optional*, default = "false"
A value of '`true`' will display the message on the level info page

showstart, *optional*, default = "false"
A value of '`true`' will display the message on startup of the level. Please use this feature only in rare cases.

Contents:

The dedication message itself. It may be broken into several lines. Whitespace will be collapsed before display.

code, *optional, single occurrence*

Attributes:

none.

Contents:

The main code comment, which may be an explanation of the Section 3.3.2 [<version>], page 30, status or a to-do list. It may be broken into several lines. This comment will not be processed.

3.3.9 <score>

In this node, the author should provide his own scoring values as hints and a challenge for other players. All values are related to the control mode defined in Section 3.3.7 [<modes>], page 35.

```
<el:score el:easy="01:07" el:difficult="-"/>
```

Attributes:

easy, *required*
The solution time for the easy mode. The format is either **MM:SS**, where MM stands for the minutes, and SS for the seconds, or **-** if the author did not yet

solve the level him/herself. For levels with a score unit mode '`number`', the value would be the number of marble moves or pushes.

difficult, *required*
: The solution time for the difficult mode. The format is either **MM:SS**, where MM stands for the minutes, and SS for the seconds, or **-** if the author did not yet solve the level him/herself. For levels with a score unit mode '`number`', the value would be the number of marble moves or pushes.

Contents:

3.4 LUA code

This element takes any Lua code as a single chunk with nearly no limitations:

```
    <el:luamain><![CDATA[
levelw = 20
levelh = 13

create_world( levelw, levelh)
draw_border("st-wood")
fill_floor("fl-leavesb", 0,0,levelw,levelh)

oxyd( 4,4)
oxyd( 14,4)

document(5,10,"hint1")
document(10,10,"hint2")
document(10,5,"Heureka!")
set_actor("ac-blackball", 4, 11)
    ]]></el:luamain>
```

Attributes:

none

Contents:

This element takes the main Lua code as its contents.

All other possible libraries that are declared as dependencies, and Lua chunks supplied by XML elements are preloaded as described in Section 3.3.6 [<compatibility>], page 33. Generally there is no more need to use Lua functions like '`Require`' to load libraries. Just in case you need to control the point of execution were the library must be loaded, you can declare the library with the attribute '`el:preload="false"`'. You should use the new function ⟨undefined⟩ [enigma.LoadLib], page ⟨undefined⟩, to load the library.

The Lua code that is enclosed in a XML CDATA section. This limits the Lua code not to use the reserved end marker '`]]>`'. Any occurrence must be substituted by '`]] >`'.

On the other hand, the XML format extends the Lua capabilities to the use of encodings. You may use Lua strings and comments with Umlauts, but Lua identifiers are still limited to pure US-ASCII. The benefit is that you can use Umlauts and other non-ASCII characters within it-document hints.

3.5 Internationalization (i18n)

The internationalization of levels is a driving force behind the level format changes. As you may have noticed, there are two ‘i18n’ elements, one in the author’s protected section and one in the public. Let us review how to use them for internationalization of the three documents of our ‘demo_i18n.xml’ level:

```
<el:protected >
  <!-- elements omitted -->
  <el:i18n>
    <el:string el:key="title">
      <el:english el:translate="false"/>
    </el:string>
    <el:string el:key="subtitle">
      <el:english el:translate="true"/>
      <el:translation el:lang="de">Übersetzten oder übersetzten lassen</el:translation>
    </el:string>
    <el:string el:key="hint1">
      <el:english el:comment="Let 'right' be ambiguous: correct and op-
posite of left - if not possible choose correct">Read the right document</el:english>
      <el:translation el:lang="de">Lies das rechte Dokument</el:translation>
    </el:string>
    <el:string el:key="hint2">
      <el:english el:comment="the correct one and not the right positioned one">The r
      <el:translation el:lang="de">Das rechte, nicht das rechte</el:translation>
    </el:string>
    <el:string el:key="Heureka!">
      <el:english el:translate="false">Heureka!</el:english>
    </el:string>
  </el:i18n>
</el:protected>
<el:public>
  <el:i18n>
    <el:string el:key="hint1">
      <el:translation el:lang="fr">Lisez la document de droite</el:translation>
    </el:string>
  </el:i18n>
</el:public>
```

Two of the documents use key words to reference a string. The last one uses the English string itself as the key. There are two additional reserved keys, ‘title’ and ‘subtitle’.

For each string we like to translate or have translated, we define a ‘string’ subelement of the protected section and add a ‘english’ subelement to the ‘string’ element itself. The ‘string’ element just takes a single mandatory attribute, the key of the string. The ‘english’ element has a single mandatory attribute ‘translate’ that defaults to ‘true’, stating the author’s decision whether the string should be translated. If the author does not want a string to be translated, he can and must simply add no ‘string’ element for this string at all. Thus, the elements for the strings with the keys ‘title’ and ‘Heureka!’ are optional and quite unusual.

'`title`' and '`subtitle`' display the English text in the Section 3.3.1 [<identity>], page 30, element. All other strings referenced by keys need to add the English text as the content of the '`english`' element. '`hint1`' and '`hint2`' are examples.

Because we chose quite ambiguous English texts, it is very likely that translators who do not play the game but just translate the text, may deliver a wrong translation. To avoid mistakes, a level author may add a '`comment`' attribute to the '`english`' element. The translator receives this comment with the English string as we will see later.

If the author is not native English-speaking, he should add his own '`translation`' subelement to the '`string`' element. The '`translation`' element has a single mandatory attribute '`lang`' that takes the 2-character language abbreviation. The contents of the element is the translation itself.

All translations added in the protected section take precedence over any translator's translation and will work directly after addition without waiting for a translator's translation.

Last but not least, we have an '`i18n`' element in the public section. This element takes translation suggestions. The author may add them him/herself for other languages he/she knows. They may be added by others on the way to the user, or even by the user himself.

Translations in this section will work immediately after addition without waiting for a translator's translation. However, available translations, provided by translators, will precede them.

The format is identical to the protected section, with the exception that no '`english`' element may be provided. The '`key`' attribute in the '`string`' element must match exactly the '`key`' attribute in the corresponding '`string`' element in the protected section. One subtle difference exists, due to technical and practical reasons. '`key`' attributes in the public section need to be XML identifiers; thus, you cannot provide public translations for strings that use the English phrase as the key. Choose a keyword and provide the English string in the public '`i18n`' section to avoid these troubles.

The '`string`' element in protected section and in the public section must be unique concerning the attribute '`key`' within the section. This means you should add translations for all known languages for a string in '`string`' element in the protected and in the public section. The sequence does not matter.

Let us review what the translator receives for each string. Let us start with '`hint2`' for the German translator:

```
#  level: "Demo Internationalization"
#  author: "Ronald Lamprecht" email "ral@users.berlios.de"
#  comment: "the correct one and not the right positioned one"
#  use: "Das rechte, nicht das rechte"
#: po/level_i18n.cc:17
msgid "The right one, not the right one!"
msgstr ""
```

'`msgid`' is the English string. '`msgstr`' takes the German translation. But the translator does not need to translate since the author provided the German translation in the '`# use:`' line

As another example, '`hint1`' for the French translator:

```
#  level: "Demo Internationalization"
#  author: "Ronald Lamprecht" email "ral@users.berlios.de"
#  comment: "Let 'right' be ambiguous: correct and opposite of left - if not pos-
sible choose correct"
#  check: "Lisez la document de droite"
#: po/level_i18n.cc:14
msgid "Read the right document"
msgstr "Lisez le document de droite"
```

Here the author gives the public translation in the '`# check:`' line. Since it contains at least one mistake, the translator will correct it, as shown in the '`msgstr`' string.

3.6 Usage

After all the theory, let's look at how to deal with the XML levelformat in practice. Of course, you will not assemble all XML metadata from scratch for every new level you write. You should use templates. You can start with any existing level, for example, the '`demo_i18n.xml`' supplied with this documentation. Add your personal data to your template and store it as the basis for all new levels you write.

Some level authors are very familiar with the Lua file format since their favorite editor supports Lua files with syntax coloring. The XML file name and the XML elements will cause their editor to use XML syntax coloring. Nevertheless, these authors are used to supplying metadata in the header of their Lua levels as non-standardized Lua comments; we decided to support a similar Lua-compatible XML format. We call it "Lua commented XML" since it simply comments out all XML lines with the Lua comment '`--xml-- `'. For example:

```
--xml-- <?xml version="1.0" encoding="UTF-8" standalone="no" ?>
--xml-- <el:level xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLoca
--xml--   <el:protected >
--xml--     <el:info el:type="level">
--xml--       <el:identity el:title="Demo Simple" el:id="20060210ral001"/>
--xml--       <el:version el:score="1" el:release="1" el:revision="0" el:status="stabl
--xml--       <el:author el:name="Ronald Lamprecht"/>
--xml--       <el:copyright>Copyright © 2006 Ronald Lamprecht</el:copyright>
--xml--       <el:license el:type="GPL2" el:open="true">GPL v2.0 or above</el:license>
--xml--       <el:compatibility el:enigma="0.92"/>
--xml--       <el:modes el:easy="false" el:single="true" el:network="false"/>
--xml--       <el:score el:easy="-" el:difficult="-"/>
--xml--     </el:info>
--xml--     <el:luamain><![CDATA[
levelw = 20
levelh = 13

create_world( levelw, levelh)
draw_border("st-wood")
fill_floor("fl-leavesb", 0,0,levelw,levelh)

oxyd( 4,4)
oxyd( 14,4)
set_actor("ac-blackball", 4, 11)
--xml--     ]]></el:luamain>
--xml--     <el:i18n/>
--xml--   </el:protected>
--xml-- </el:level>
```

Please note that each XML metadata line must start exactly with '`--xml-- `', 8 characters, including the space at the end! An additional limitation of the Lua-commented XML format arises from Lua's capability of handling character encodings. You need to limit yourself to '`UTF-8`' or, of course '`US-ASCII`' to successfully use the Lua-commented XML format. Please remember, that although the XML part is Lua-commented, it must still be evaluated and thus must be valid.

Every level stored in this Lua-commented XML format as a file with extension '`.lua`' can be used locally for command line use as well as in any level package that is stored on the Enigma user's home directory. However, Lua-commented XML levels cannot be stored on Internet servers or be updated online. Thus, this format is good for level development, but you should convert the levels to the pure XML format for distribution. Please note that Enigma looks for XML levels first, and uses Lua levels only if it can't find an XML level.

Another use of Lua-commented XML levels is the format backward compatibility to Enigma 0.92. If levels do not use new Enigma features, you can include your levels in Enigma 0.92 level packages in this format.

Since you may need to convert levels several times between the XML and the Lua format, we do provide tools for conversion: '`xml2lua`' and '`lua2xml`'. Both are very simple Lua 5 scripts that you can execute as '`lua xml2lua demo_simple.xml > demo_simple.lua`' with a properly installed Lua 5 version. On Unix systems, you can mark the scripts as executable and simply call '`xml2lua demo_simple.xml > demo_simple.lua`'.

Of course you can add the conversion algorithms as simple macros for your favorite editor. Please publish any editor macros you write.

As you fiddle with the XML metadata, you may produce syntactical errors, of course. You can validate your level by trying to start it with Enigma. XML errors are output as Lua errors are. If the error messages are too long to read, you may want to start Enigma from the command line with the option '`--log`' and read the messages printed to the command line or written to the file '`stdout.txt`' on the current working directory for Windows systems.

Of course, you can use any external XML validation tool, too. You just need to copy the schema file '`level.xsd`' on the same directory as the level itself. Possible validation tools are the Xerces-C sample application '`DOMPrint.exe -n -s -f -v=always level.xml`' or validating editors, such as Exchanger XML Lite (`http://www.freexmleditor.com/`). Such editors will provide you with selections of all possible elements and attributes at each position.

3.7 Update and Upgrade

Enigma is able to load new level versions since we provide all necessary attributes in the Section 3.3.2 [<version>], page 30, element.

If Enigma loads a new level version, which differs just in the '**revision**', we speak of an '**update**'. You can perform updates automatically and replace old versions with the updates, since the author guarantees them to be compatible in scoring and dependencies. The author should provide a download address for automatic updates in the protected info element:

```
<el:update el:url="http://myLevelServer.org/path/level_1.xml"/>
```

Attributes:

url, *required*
: A long-term valid, complete address for update downloads of this level in the same score and release version.

If the author of a level introduces incompatibilities into the level, he increases the release version of the level and stores it with a new filename. We call the download of such a new level version an '**upgrade**'.

To publish the availability of an upgrade release, the author should update the previous release with a final revision that simply adds an upgrade element that announces the new release:

```
<el:upgrade el:url="http://myLevelServer.org/path/level_2.xml" el:release="2"/>
```

Attributes:

url, *required*
: A long-term valid, complete address for upgrade downloads of this level. A path to the new file.

release, *required*
: The release version of the upgrade.

Since the author cannot update all distributed levels himself to announce the availability of the new release, we added another upgrade element in the public section. Level administrators can use this element for the same purpose, with the same syntax, without modifying the author's protected section.

3.8 Library Files

Libraries are collections of Lua functions for reuse in many levels. To use a library, you must declare it as a dependency, as described in Section 3.3.6 [<compatibility>], page 33. Preloading the library is all you have to do to use the library. Otherwise, you can use the function ⟨undefined⟩ [enigma.LoadLib], page ⟨undefined⟩, to load the library at a certain point of execution.

Enigma provides several very useful Chapter 12 [Libraries], page 335. You will find them on the system path in the subdirectory '`levels/lib`'. Most of them are documented in-line. You will find a separate documentation file '`doc/ant_lua.txt`' for '`ant`'.

In this section, we will concentrate on the aspects of writing and maintaining libraries:

3.8.1 Writing a Library

Library files are nearly identical to level files. The main difference is the attribute '`el:type`' in the '`info`' element, which you should set to '`library`'. You must provide all other elements and attributes as you must for levels. Of course no scoring related attributes will ever be evaluated and you should set them to default.

Libraries may depend on others, so you must provide an id and a release number. Several releases of a library can coexist and you can update and upgrade them if you provide the necessary information. Of course, libraries may contain document strings that can be localized if you provide the '`i18n`' elements.

The '`el:luamain`' element takes the complete Lua code as it does for levels. Let's look at the essential XML parts of a library:

```
<?xml version="1.0" encoding="UTF-8" standalone="no" ?>
<el:level xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation="http
game.org/schema/level/1 level.xsd" xmlns:el="http://enigma-game.org/schema/level/1">
  <el:protected >
    <el:info el:type="library">
      <el:identity el:title="" el:id="lib/ant"/>
      <el:version el:score="1" el:release="1" el:revision="0" el:status="released"/>
      <el:author  el:name="Petr Machata"/>
      <el:copyright>Copyright © 2002-2003 Petr Machata</el:copyright>
      <el:license el:type="GPL v2.0 or above" el:open="true"/>
      <el:compatibility el:enigma="0.92">
        <el:dependency el:path="lib/natmaze" el:id="lib/natmaze" el:release="1" el:preloa
      </el:compatibility>
      <el:modes el:easy="false" el:single="false" el:network="false"/>
      <el:score el:easy="-" el:difficult="-"/>
    </el:info>
    <el:luamain><![CDATA[
    ...
    ]]></el:luamain>
    <el:i18n/>
  </el:protected>
</el:level>
```

3.8.2 Maintaining a Library

Libraries may exist in different releases and revisions. Library versions that differ simply in the revision, denote compatible versions. Library versions that introduce incompatibilities must differ in the release number. However, since existing levels may depend on the legacy behavior of the older release, you must maintain both library release versions and distribute them with Enigma at the same time.

To coexist, these different library releases must follow a strict naming scheme. Every library has a base name. In the example above it is '`lib/ant`'. The filename of a given release is the basename with the addition of an underscore and the release number plus the suffix '`xml`'. Thus, you must store release '`lib/ant`' as '`lib/ant_2.xml`'.

If you look at the lib directory, you may wonder that Enigma stores most library files without release number addition to the basename. This is due to 0.92 Lua level format compatibility support. You can store one, and of course only one, release of each library without release number addition to the basename. Enigma will load this version from pure Lua levels that do not provide any information of the required library release.

If a library file with a complete filename is not present, the default library file without release number addition will be loaded for XML load requests, too. Yet the future belongs to the new naming scheme, and every new library should follow it from the beginning.

3.9 Multilevel Files

Another concept of code reusage besides Section 3.8 [Library Files], page 43, are multilevel files. The code contained in a single file generates several levels, called sublevels, that appear as autonomous levels in a levelpack. Of course this concept is much less flexible than the library concept as other level files can not reuse the code. But you can write a multilevel if you wrote a lot of specific code for a complex level that provides more than just two variants, which would be otherwise presented as '`difficult`' and '`easy`' Section 3.3.7 [<modes>], page 35.

But the main reason for multilevel files is the support of foreign game level formats like Sokoban, which describe a whole set of levels in a single file. Enigma imports these original files with just a few lines of code. It would be inefficient, even though being possible, to write an Enigma level stub for every level imported from a single foreign file.

But multilevel files have some restrictions. They use a single set of XML level metadata. Thus these metadata must fit to all levels. The Section 3.3.2 [<version>], page 30, will be identical as it reflects either the code version of the native level or the version of the imported foreign file. But the other data like Section 3.3.3 [<author>], page 32, Section 3.3.6 [<compatibility>], page 33, and Section 3.3.7 [<modes>], page 35, have to match, too. If they do not, you can not use a multilevel file.

Just the values for '`title`' and '`id`' will and have to differ for all levels described by a single multilevel file. There exists special support for multilevels to handle these attributes.

Let us look at all attributes and features of multilevels that differ from standard level files.

First you have to declare in the Section 3.3 [Info metadata], page 28, element the type as `"multilevel"` and to provide the quantity of generated levels. The sublevels will be numbered from 1 to the given quantity.

In the element Section 3.3.1 [<identity>], page 30, you have to provide just one unique level id value. Enigma will automatically append the string `"[1]"` for the first sublevel, `"[2]"` for the second and so on. Thus every sublevel has an unique id.

Additionally you should provide a base title for the levels in this metadata Section 3.3.1 [<identity>], page 30, element. If your title ends with a hash '`#`' sign Enigma will autogenerate titles for the sublevels by appending the sublevel number to the given common title string.

For individual sublevel titles the Section 3.4 [LUA code], page 38, has to provide the titles. The title in the Section 3.3.1 [<identity>], page 30, element may not end on a hash sign and will only be used as a default title base in case the Section 3.4 [LUA code], page 38, fails to provide a sublevel title. Prior execution of the Lua code the global attribute Section 6.4.29 [SublevelNumber], page 145, gets initialized. The Lua part has either way to load the appropriate sublevel based on this number. Now it has additionally the task to set the second special multilevel global attribute Section 6.4.30 [SublevelTitle], page 145.

Section 3.3.6 [<compatibility>], page 33, externaldata

4 Enigma Paradigm

Now that you have learned about the formal declarative XML part of a level you should be eager to understand the basic principles of the participants of an Enigma level world. In this chapter we explain all the fundamental concepts and the terms used in the following chapters that describe the level author's view of a level.

Please note that we describe the features of the new API of Enigma 1.10. The API of the earlier releases does not provide all the features and differs in several aspects.

4.1 The World's Structure

We speak of a level as the opus as a whole that describes the initial composition of a gaming world and its dynamic behaviour during the game play. Let us look at the participating objects in details.

4.1.1 World's Shape and Coordinates

Having played a few levels you will have noticed that every screen shows quadratic tiles, 20 ones in the horizontal and 13 ones in the vertical direction. Even if it is difficult for a player to map together all rooms and screens of a large level, every level world has the shape of a rectangle in whole. Nevertheless some parts may never be visible to the player due to walls of stones or oceans of water.

On the creation of a world the level author has to give its size in measure of tiles. The given width and height of the world are fixed and cannot be changed later on. A common size is 20x13 for a *Onescreener*. But there are no limits. You can even build levels smaller than a screen. Note that for larger levels you have to take into account that one tile row or column is usually shared between two screens on scrolling. Thus a level of 2x2 screens has a size of 39x25 tiles, a 3x4 screen level has 58x49 tiles,...

Looking at the edges of all the tiles we get a grid that spans our world. We define the upper left corner of our world as the *position* {0, 0}. The first coordinate is the horizontal offset to the right, the second coordinate the vertical offset to the bottom. For a Onescreener level the tile in the lower right corner is located at position {19, 12}, whereas the corner itself is at the position {20, 13} (Note that this point is actually not part of the level anymore).

A position of an actor like the black marble needs to be given by two floating numbers as coordinates like {1.5, 2.5} for an actor positioned in the center of the tile that is one column right and two rows down of the upper left corner tile.

But most objects like stones can only be placed on the fixed integral grid positions. Even if you try to put a stone on {1.5, 2.5} it will be put on the grid position {1, 2}. Thus we speak of a *grid position* if just the integral part is taken into account. You may note that a tile is positioned according to its upper left corner. Actually the upper and the left edge are part of a tile, whereas the right and lower edge belong to the neighbour tiles.

Finally let us look more precisely on the tile itself. On one grid position you may place a floor, an item, a stone and even several actors. The combination of all objects on one grid position is called a *tile*. It is a common technique to declare these object combinations once in so called tile definitions. As many grid positions share the same combination of objects these tiles can be reused very efficiently.

4.1.2 Object Layers

On every grid position you may set a floor, an item and a stone. But just one of each. If you set a second stone the first one will be replaced. Floor, item and stone have a unique physical arrangement with the floor always being below an item and a stone always being on top of the others. Thus we speak of three object *layers* - the floor layer, the item layer and the stone layer.

The floor layer has a unique prerequisite. Every grid position needs to be covered by a floor. You can define a default tile which contains a *default floor* that gets automatically set on every grid where you set no other floor. Even if you *kill* a floor, that means removing a floor without setting a replacement floor, a default floor will be set for you.

The floors provide two elementary features to the game: friction and adhesion. The friction slows down actors and the adhesion enables you to accelerate actors with your mouse. A floor may additionally cause a directed flat force that gives the user the feeling of a slope. And last but not least a floor may burn. A whole set of attributes let you control the details of the fire behaviour.

The item layer is shared between items that an actor can pick up and items that are static. The first category are items like keys, banana, etc. Static items are bombs, landmines, triggers, hollows and items that will only be set by the system itself like laserbeams, fire animations, ash, etc. As only one item can be positioned on every grid position a marble can not drop an item on such a static item. This is the technical reason that you can not intercept a laser beam by dropping an item. But as a level author you are free to add any item you like to the initial grid tile.

The stone layer is straight forward. The level author can choose a stone out of the repository per grid. Of course most grid positions should be kept free for the actors to move around. Even if most levels have a stone wall at the border of the world that visually limits the area this is not mandatory. Without a stone wall the marbles will be bounced at the physical boundary of the world.

The actors live in another layer that is not grid based. The actors can be placed at any position. Actors that pass a stone will be displayed below the stone.

4.1.3 World as an Object

Friction, Brittleness, Modes and Co., Scrollmodes

4.1.4 Unpositioned Objects

You should be missing at least one object, that can neither be assigned to a single position nor to one of the above layers: rubberbands! In fact there are many Chapter 11 [Other Objects], page 330, besides floors, items, stones and actors that are unpositioned. Besides visible rubberbands and wires useful gadgets, that help in plug and play composition of levels, can be added to the world.

All these other objects are full objects concerning the following chapters. But you need to use the world's Section 5.13.5 [add], page 110, method to add them and you need to use Section 4.2.2 [Object Reference], page 49, or Section 4.2.3 [Object Naming], page 50, to access them later on, as no position driven access does exist.

4.1.5 Player and Inventory

Enigma is conceptionally a game for 2 players. But nevertheless it can be played by one user on a single computer by toggling the control between two virtual players. We do call these virtual player's `YIN` and `YANG`, as the first player controls in most cases a black marble, whereas the second controls usually a white marble.

Each virtual player has its own inventory of up to 13 items. The leftmost item of the inventory is called '`revealed`', as an item activation by a mouse click does activate this item and on actor hits this item may cause special actions.

The players inventories do exist outside of the rectangular world. Thus any item being part of a player's inventory will report an invalid, out of world position, that evaluates on an '`exists()`' request to '`false`'. You can add items directly to inventories by the advanced world method Section 5.13.5 [add], page 110.

Even though the actors are assigned to players they are quite independent objects that live in one of the Section 4.1.2 [Object Layers], page 47. Their relationship to players is as follows:

Each virtual player can own and control one or several actors of any kind. That means player `YIN` is not limited to a black Section 10.2.4 [ac_marble], page 325, but may as well control a white Section 10.2.5 [ac_pearl], page 326, an Section 10.2.2 [ac_horse], page 322, or any other set of one or several arbitrary actors.

Ownership and control of actors are two distinct aspects. Ownership of an actor means that every item picked up by an actor ends up in the player's inventory and items of the player's inventory can act on all owned actors. The control of an actor by a player does just affect the movement of the actor by the users force input. An actor may be controlled by a player without parallel ownership. Another actor may be owned by a player without being controlled by it, thus being a passive actor that depends on being pushed by others. An actor may even be controlled by both players, but it can just be owned by one player or none.

The assignment of actors to players is solely configured by Section 10.1 [Actor Attributes], page 320.

When a single user plays Enigma he starts with the control over the player `Yin`. By usage of yinyang objects he can toggle the control to the player `Yang` and back again. Items Section 8.3.35 [it_yinyang], page 209, are added automatically for network levels when played by a single user. They allow an arbitrary switch between the players. The stones Section 9.5.71 [st_yinyang], page 316, do limit the user's ability to switch between the player control.

4.1.6 Owned Objects

Besides objects owned by a player and being part of his inventory, objects can be temporary part of another object. The most obvious case is an item contained in an Section 8.3.1 [it_bag], page 184. Other samples are two Section 9.5.59 [st_shogun], page 300, stones pushed onto the same grid position or for a short fraction of time a stone swapping the position with an Section 9.5.63 [st_swap], page 306, or an Section 9.5.51 [st_pull], page 291.

In any case the owned object will report the same position as the owner itself. Even in case of some items contained in a bag that is itself part of another bag all items will report the same position as the outmost bag. If this bag is part of a player's inventory all items report an invalid position.

You can not directly enforce ownership by setting two objects to the same position as this standard operation will kill and replace the old object by the new one. Where possible, like in the case of a bag, you can add objects to a container object by usage of the world advanced method Section 5.13.5 [add], page 110.

4.2 Object Description

Knowing where to place objects it is time to know how to select an object type, how to specify the details of the object and how to reference it later on.

4.2.1 Object Kind

Up to now we have spoken about object kinds of floor '`fl`', item '`it`', stone '`st`' and actor '`ac`'. All these kinds are called *abstract*. You can check if a given object is of such a kind, but you can not instantiate an abstract kind.

To create an object you need to give a specific kind name like '`st_switch`'. You will find all object kinds described in the chapters starting with Chapter 7 [Floor Objects], page 148. All these kind names with at least one underscore can be instantiated.

Most kinds provide subkinds like '`st_switch_black`' and '`st_switch_white`'. In case of the switches you get a color independent switch if you do not append a suffix. In other cases like '`st_chess`' the super kind will result in a default '`st_chess_black`' as no colorless chess stone exists.

If you request an object for its kind it will always return the most specific kind. This means that a fresh generated '`st_chess`' returns the kind '`st_chess_black`', whereas an '`st_switch`' reports its name unchanged.

Objects can change their kind by level code statements or by user actions. You may set a color on a switch or a marble may cause a color change on a chess stone by hitting it with a revealed wand. The object will report the new kind on subsequent requests.

A few special object kinds do exist only for setting a new object. They are usually named with a suffix '`_new`'. These objects will never report their initial kind name but change to a standard kind immediately.

If you are not interested in the specific subkind you can check an object for conformity to any super kind. E.g. any switch stone of whatever color will return true if checked for '`st_switch`'.

4.2.2 Object Reference

Having set objects to the various layers a level author sometimes has the need of referencing them later on. On callbacks the engine provides references to sender objects. But the author can request any grid object anytime by its position.

With an object reference, that is of a special Lua type '`object`', you can request the objects on its current state and attributes, modify the object, send messages or perform any supported methods of the object.

Objects can be grouped for efficient handling of common operations on all affected objects. E.g. if you can send a message to a group of objects all objects will receive the message in turn. The sequence of several objects in a group is constant and guaranteed to be observed in processing common operations.

As objects can seize to exist you have to be aware that the references are volatile, too. You can check every object reference for existence. But in many cases the validity of the reference is unimportant as Enigma 1.10 is very tolerant on invalid object references access. The operations will simply be ignored and requests will return default values.

As a general thumb rule you should request and keep object references just for the time of a local call. As long as your level code is processed in sequence without the running world simulation giving the player a chance to kill objects by marble actions, objects should seize to exist just due to your own direct statements.

To gain access to an object later on a subsequent call you can address it via two methods. First you can address it via its position. But as many objects are movable the position is not constant. Therefore you can address an object by name. See Section 4.2.3 [Object Naming], page 50.

4.2.3 Object Naming

For addressing objects on a long term valid basis every object can individually be tagged by a name. Assigning a name to an object is as simple as setting the attribute '`name`' with a unique string on this object. Of course you can request an objects name by reading the attribute '`name`'.

The name is a string that should be made up of characters '`a..z`', '`A..Z`', numbers '`0..9`' and the underscore '`_`'. Other special characters are only allowed as far as they are explained in the following text.

It is up to you to ensure unique names. Reuse of an already assigned name will unname the prior object and assign the name to the new object. To simplify the naming of larger groups of similar objects you can add the hash sign '`#`' as the last character to a name, e.g. '`mydoor#`'. This causes Enigma to add a unique random number to the given string. Thus an auto named object will never unname another prior auto named object. But if you delete an auto named object that has been named e.g. '`mydoor#103284`' the number and the same name may be assigned to another that is created later on.

All named objects are registered by the *named object* repository. The API provides a variable '`no`' that allows you to retrieve any named object, e.g. '`no["mylaser_a"]`'. You get an Section 4.2.2 [Object Reference], page 49, or '`nil`', if no object is registered by the given name.

As you can auto name groups of objects you are allowed to use the wildcard characters '`?`' and '`*`'. The question mark replaces a single arbitrary character, the asterisk any number of arbitrary characters. E.g. '`no["mydoor#*"]`' retrieves all auto named '`mydoor`' objects in a single object group.

Many object attributes like '`target`', '`destination`' need object references to other objects. Besides a volatile Section 4.2.2 [Object Reference], page 49, you always can provide a name string as a long term valid object reference. If the attribute allows several objects to be given you can either give a group of object references, a table of object names or an object name with wildcards. Thus the string '`"mydoor#*"`' is a valid target.

Often switches are located near by their target object. As a major shortcut you can reference the nearest object out of a group by prefixing its name with an '`@`' character.

```
ti["F"] = {"st_floppy", target="@door#*"}
ti["D"] = {"st_blocker", name="door#"}
```

With this tile declaration you can describe arbitrary number of floppy switches and nearby blocker doors in a world map all by the same two tile key characters. Every floppy switch will target the nearest blocker door. If two targets are given within the same distance the one located in the south will win. If the targets are additionally horizontally aligned the one located in east will win. In the rare case of objects located on the same position stones will precede items, floors and actors. The chosen target or destination depends just on the location of these objects and their type, but nothing else. Thus you can rely on a stable selection mechanism. Section 13.3.1 [Nearest Object Clustering], page 396, may help you in case of unexpected selected equidistant targets.

Auto naming and nearest object features help you to reduce the number of needed tile declarations. Resolvers like Section 13.1.3 [res.autotile], page 374, and Section 13.1.4 [res.composer], page 377, are another feature for reducing the need of tile declarations.

Another unique feature of object names is their late on access evaluation. This allows you to reference an object prior to its existence. E.g. if you want to set two vortices each declaring the other one as its destination, object names are the favorite solution:

```
wo[{3,4}]  = {"it_vortex", name="vortex1", destination="vortex2"}
wo[{15,9}] = {"it_vortex", name="vortex2", destination="vortex1"}
```

In general you will need to use object name references within any tile declarations as none of the referenced objects will yet exist at the point of tile declarations.

Objects do change over time. Doors do open, a chess may be recolored, a blocker stone may shrink to a blocker item. This means that the kind of the objects will change. But in many cases this means that the volatile object reference will brake, too. For the sake of the level authors the identity of the object will be transferred even if the reference gets invalid. And like the user attributes the name is part of the object identity. Thus if you name an Section 9.5.4 [st_blocker], page 244, and it shrinks to an Section 8.4.1 [it_blocker], page 209, you will retrieve this item if you ask the name object repository for the named object.

When an object like a door is completely killed, e.g. by an Section 8.3.26 [it_seed], page 203, it can no longer be targeted by active objects like switches. A still existing reference to a no longer existing object does not cause problems on Section 4.3.1 [Messages], page 54. But what about the nearest object references? To avoid problems due to killed objects the standard nearest object reference with just one '`@`' as prefix is finalized on Section 4.4.3 [Level Initialization], page 59. This means that they get substituted by the unique name of the nearest of all existing objects at a point of time when all objects have been created, but before the user takes action and can incidentally kill a candidate.

But sometimes you may like a dynamic nearest object target or destination. One that is evaluated when it gets accessed. By prefixing a name with '`@@`' the reference will not get finalized on initialization but remains dynamic.

```
ti["c"] = {"it_coin_s", "magic#"}
ti["v"] = {"it_vortex", destination="@@magic#*"}
```

Setting three magic coins and one vortex in your map will teleport the marble to the grid of that coin that is nearest to the vortex at the moment of teleportation.

To avoid unexpected problems with invalid object references a few critical objects are internally autonamed if the level author does not provide a name. But these unique names should never interfere with the user assigned object names.

4.2.4 Object Attributes

One of the key concepts for the versatility of Enigma is possibility to fine tune objects by means of attributes. The level author is not limited to a fixed set of preconfigured objects as given by the object kind.

An attribute is a name, a string, with an assigned value. E.g. '`obj["inverse"]=true`' sets a single object attribute to a boolean value and '`{"it_magnet", range=6.5}`' describes a magnet item with an initial set floating point attribute.

The scope of values is manifold. Most Lua types and a bunch of Enigma specific types can be assigned:

- bool
- int
- double
- string
- nil, DEFAULT
- position
- object
- group
- tokens

If we speak of a bool value we do it in the sense of Lua 5, that means with the possible values '`true`' and '`false`'.

Many enumerated values like orientations and colors are covered by the integer numbers.

Of special interest is the value '`nil`'. Just a few attributes make direct use of the value '`nil`', e.g. "color" on some objects. If you set an attribute to value '`nil`' you do actually reset its value to the default value. E.g. if you set the attribute "orientation" of Section 9.5.6 [st_boulder], page 246, to '`nil`' it will be set to its default, which is actually '`NORTH`', an enumerated orientation value. A subsequent read of the attribute will return this value. Just those attributes that allow a nil value will ever return '`nil`' on a read access. As a direct consequence these attributes always default to '`nil`'.

The authors of Lua did decide to prohibit the usage of '`nil`' as a value in Lua tables. As we make heavy usage of anonymous tables as object declarations, you would not be able to set such attributes to '`nil`'. You would need to set such attributes explicitly. As a workaround we added a custom value '`DEFAULT`' that can be used anywhere to set attributes - even within Lua tables.

```
mySwitch["color"] = nil
mySwitch["color"] = DEFAULT
wo[{3,6}] = {"ac_marble_black", player=DEFAULT}
```

Note that '`DEFAULT`' is not equal to '`nil`'. They are different values concerning Lua. They just result both in attributes reset to their default. If you request a nil valued attribute you will always receive the Lua value '`nil`'. '`DEFAULT`' will never be returned by the engine.

A group is an ordered set of Section 4.2.2 [Object Reference], page 49s. As all contained objects must exist this value is seldom used for attributes in object declarations. But it is very useful for postprocessing of objects and for usage within Section 4.3.3 [Callback Function], page 56s.

The most complex attribute value type are the tokens. Their purpose is the specification of one or many objects. As Enigma provides several means to do that this value type combines and mix all possibilities. A token's value may be a string, representing an object name, an object reference, a group or a table with any of these basic types in any sequence and number. E.g. the following right sides are all valid tokens for the attribute '`target`':

```
obj1["target"] = "mydoor"
obj2["target"] = myobject
obj3["target"] = grp(ojb1, obj2, obj3)
obj4["target"] = {"mydoor", myobject}
obj5["target"] = {grp(ojb1, obj2, obj3), "mydoor", myobject, "anotherdoor"}
```

This versatility is useful to set tokens' attributes independent of the given object reference types.

The chapter Chapter 6 [Common Attributes and Messages], page 125, and its followers describe the existing object attributes in detail.

Besides these predefined attributes the level author can store own information on objects for later retrieval. Any name starting with an underscore '`_`' can be used for level specific purposes. This prefix has been chosen as the resulting names are still valid Lua names. Common usage patterns are switches or triggers with callback functions. These functions provide the sender, the switch or trigger, as an argument. If you attach the same function to number of senders you can store the necessary context information within the sender.

The internal engine uses object attributes as well. Such inaccessible attributes are named with a leading dollar sign '`$`'. They may appear in the documentation for C++ developers information. Level authors should ignore these attributes.

In some cases you may observe a different behaviour on setting an attribute within the object definition and setting the same attribute while the object is already on the grid. E.g. a door '`{"st_door_h", state = OPEN}`' is opened from the very beginning. Whereas '`mydoor["state"] = OPEN`' on a closed door will start opening the door. This takes a short time until the door is really open. You find more details on these as aspects in the section Section 4.4 [The Lifecycle of a Level], page 58.

If you ever look into the C++ code you may wonder about the implementation of attributes. They are not all directly stored in a map. Some of them are held in object instance variables, other do not exist at all. Objects' attributes are an abstract concept that unifies several internal features within a common simple API for level description code. Within the C++ engine subtle reasons like performance optimization forces a much more complex handling.

4.3 Methods of Interaction

Having looked at the description of the initial object composition of a level world we still need to understand how to configure the dynamic behaviour of a level.

4.3.1 Messages

You can generate an initially open door by setting its attributes. But how can a switch stone open a door when it is hit by a marble? It simply sends a message '`open`' to the door. Another switch may send a message '`on`' to a laser or '`ignite`' to an Section 8.3.11 [it_dynamite], page 192. On explosion the dynamite will in turn send automatically '`ignite`' messages to the neighbour grid positions.

Messages are a simple universal function or from the receiver object and the Lua level authors point of view a "method". It takes two arguments - the message name, a string, and an optional value. E.g.

```
mydoor:message("open")
myboulder:message("orientate", NORTH)

mydoor:open()
myboulder:orientate(NORTH)
```

The last two examples are a common abbreviation of the first two ones.

Messages may return a value. But most messages just return '`nil`'.

You can send any message to any object. Not supported messages are silently ignored. This is the reason that an exploding dynamite can send '`ignite`' messages to its neighbours without knowing if the objects can be ignited at all. Further on the dynamite has not to bother with the recipients of the messages. Due to messages the sender and the receiver objects are totally decoupled concerning the code base. Thus the level author just needs one method that allows sending arbitrary messages to arbitrary objects.

You should not send a message during initialization of the level. You configure the switch to send an '`open`' message to the door by Section 4.3.2 [Target - Action], page 54. Within a Lua Section 4.3.3 [Callback Function], page 56, you may send messages during runtime to any object.

All messages are listed and described in Section 6.2 [Common Messages], page 129, and the subsequent chapters.

4.3.2 Target - Action

The "target action paradigm" is a classical object oriented method that allows you to easily plug together objects. One object is triggered by a function call or by an event like an actor hitting a stone, crossing over or applying an item. You simply plug this object to another target object and tell it to send an action message. Every time the first object is triggered it will send the message to its target.

You configure such a target action by setting the attributes '`target`' and '`action`' on the first object. E.g. a for a switch stone that should open a door named '`mydoor`' you can write:

```
{st_switch, target="mydoor", action="open"}
```

Objects like the switch can be triggered on and off. Each time they will perform the action. If you would like the door to open and close in turn to the switch you need another action than '`open`'. The universal message for changing targets in their alternate states is '`toggle`'.

```
{st_switch, target="mydoor", action="toggle"}
```

```
{st_switch, target="mydoor"}
```

Now the door will toggle in sync with the switch between its open and closed state. The message Section 6.2.1 [toggle], page 129, can be used quite independent of the target object. In fact it is the default action message. As a default you may omit the action in this case as it is demonstrated by the second example.

But keep in mind that toggling just changes the state of the target. If you start with a switch in off state and an open door, the door will close when the switch in turned on. They will not sync. If you configure two switches both targeting the same door, you will have no clear relationship between the switch states and the door.

As you remember messages can take a value. Action messages are no exception. Every object sends its actions with a value, usually a bool value. A switch sends a value '`true`' if it just switched on, and a value '`false`' if it just switched off. The appropriate message for the door would be the universal message '`signal`':

```
{st_switch, target="mydoor", action="signal"}
```

Now the door will open when the switch is turned on and close if the switch is turned off.

The message Section 6.2.3 [signal], page 130, takes an integer value of '`0`' or '`1`'. Indeed the action value does not match. But in this as in many other cases the messages and values are designed in a way that they are automatically converted to the appropriated type. This compatibility is the basis for a seamless plugging of objects.

In many cases authors face the task of triggering two or more objects by a single object. '`target`' and '`action`' are both able to take multiple values. '`target`' is of type tokens, as described in Section 4.2.4 [Object Attributes], page 52, whereas '`action`' can be a string or a table of strings.

```
{st_switch, target={grp(ojb1, obj2, obj3), "mydoor", myobject, "anotherdoor"},
            action={"toggle",             "open",   "turn",   "close"}}
```

All objects described by a token receive the related message in the action table. If not enough messages are listed the default action '`toggle`' will be sent.

Usually actions are performed at once. That is very important as the sequence of actions if often essential. Consider an Section 9.5.7 [st_box], page 248, being pushed from one Section 8.4.18 [it_trigger], page 226, to a neighboring one, or just an Section 10.2.4 [ac_marble], page 325, moving from the first trigger to the neighboring one. In both cases it is important that the first trigger is released prior the second one to be pressed. If this sequence gets mixed up both triggers could be pressed by a single object for a moment what could cause major shortcuts in a level. Thus all actions are performed in the logical sequence and in a stable, repeatable sequence without any random.

Action may be simple or sometimes be very complex world rearrangements. But in any case you should **never ever** '`kill`' the sender object. Killing the sender can cause application crashes! Be aware that even chained actions are not allowed to kill any prior sender object. Thus an Section 8.4.18 [it_trigger], page 226, that toggles an Section 9.5.64 [st_switch], page 307, which in turn kills the first trigger is as critical as the trigger killing itself. We do generally discourage you to kill any object within its own action, as there is no dissolving animation and the WYSIWYG user paradigm is violated, too. But if there is urgent need for reasons of the level gaming logic you can perform the action in a secure, delayed mode.

Just add the attribute Section 6.1.6 [safeaction], page 127, with value '`true`' to the self killing sender object. The action will no longer be performed at once, but with a minimum delay in a manner that will never cause crashes. But be aware that even a minimum delay, which is still within the same timeslice, may disturb the sequence of actions. This can cause unexpected logical results on the other hand.

4.3.3 Callback Function

The most powerful extension to the Section 4.3.2 [Target - Action], page 54, paradigm that you can think of are callback functions. Instead of a target object as receiver of an action message you can supply an own Lua (`http://www.lua.org`) function that is called whenever the action is triggered.

```
{"st_switch", target="my_magic", action="callback"}
{"st_switch", target="my_magic"}
```

The '`target`' is the name of the function as a string. You may set the '`action`' to the string '`"callback"`' for purpose of clarification, but it is not necessary as you see in the second example. The engine identifies the target to be of type of a Lua function and thus the action needs to be a callback. But you should note and remember that it is up to you to ensure that all object names and callback functions names are unique.

Let us look at the syntax of such a callback function

```
function my_magic(value, sender)
    if value == true then
        wo[sender + {1,0}] = {"it_coin_s"}
    end
end
```

The function is called with two arguments. The first one is a value. The type and contents depends on the issuing object, but in most cases it is a boolean value. You will find the value described in the objects description. The second argument is the reference of the calling object.

In the example we check if the Section 9.5.64 [st_switch], page 307, did just toggle to ON. If this is given we take the switch, which is the sender, as a position and set a new Section 8.3.8 [it_coin], page 190, to the grid east of it - a small bank automate that supplies money.

The Section 5.3 [Advanced Lua Examples], page 78, will show examples of real powerful callback functions with a line by line comment.

Further usage and aspects of callbacks in the level's lifecycle are given in the section Section 4.4.6 [Callbacks and Load Balancing], page 60.

4.3.4 Object State

A key concept for the ability to plug together objects like switches and doors are the very simple state machines of these objects. Most objects are described by simple machines with just 2 states like '`ON`','`OFF`' or '`OPEN`', '`CLOSED`'. These objects can be plugged together by just few common messages. Further on these simple state machines are suited to the gamers who do not want to read manuals but want to explore the objects by playing with just a few tests.

Even though states are usually named by appropriate uppercase names like above, the states are integer numbers starting with '0' usually related to the default state. But some objects use another mapping due to historic reasons. E.g. states that are orientation related use the state '3' representing 'NORTH' usually as the default and number the orientations clockwise down to '0' representing 'WEST'.

In most cases it is sufficient to perform a state independent common action like Section 6.2.1 [toggle], page 129. Even two stated objects can be easily synchronized by the standard action Section 6.2.3 [signal], page 130. But sometimes you may want to perform very state specific actions. Let us look how this can be done.

E.g. let us take an Section 9.5.25 [st_fourswitch], page 264, that has four states, and two Section 9.5.34 [st_laser], page 272, which should be switched on and off. Both lasers should emit their beams while the fourswitch is in 3 of its states. But one of them should be off just while the fourswitch is in the 'EAST' state and the other should be off just while the fourswitch is in the 'WEST' state. This can be done by usage of state dependent target and actions:

```
{st_fourswitch, target_3="laser#2", action_3="on",
                target_2="laser#1", action_2="off",
                target_1="laser#1", action_1="on",
                target_0="laser#2", action_0="off"}
```

Adding a number as suffix to 'target_' and 'action_' gives you special target and action attributes that will take precedence over the general 'target' and 'action' attributes if the state value equals the suffix number. An alternative declaration would be:

```
{st_fourswitch, target={"laser#1", "laser#2"},
              action_3={"nop",     "on"},
              action_2={"off",     "nop"},
              action_1={"on",      "nop"},
              action_0={"nop",     "off"}}
```

Here we do address both lasers in all states. But one of them receives a Section 6.2.2 [nop], page 130, message that stands for "no operation". In fact this message will never be send. It is just a dummy message that we have need of for syntax reasons in the case above.

Another example are two Section 8.4.18 [it_trigger], page 226, that switch a laser. An object pressing the first trigger should switch the laser on, an object pressing the second trigger should switch it off. But a trigger is two stated and performs one action on being pressed and another on being released. Thus we want to block the actions on trigger release events:

```
{it_trigger, name="on_trigger",  target="laser#1", action_1="on", action_0="nop"}
{it_trigger, name="off_trigger", target="laser#1", action_1="off", action_0="nop"}
```

The blocking of 'action_0' is essential and can not be omitted, as otherwise the default action would be performed. This would be a 'toggle' message that would switch the laser.

As this useful default mechanism can sometimes be annoying you can switch off the default message by setting the Section 6.1.5 [nopaction], page 126, attribute to true.

```
{it_trigger, name="on_trigger",  target="laser#1", action_1="on", nopaction=true}
{it_trigger, name="off_trigger", target="laser#1", action_1="off", nopaction=true}
```

When an objects leaves a trigger the state '`0`' action will be performed. As neither '`action_0`' nor '`action`' is specified the default action will be performed, which is now '`nop`'.

If you ever look into the C++ code you may note that many objects do have much more complex state machines than you expect from the level authors and gamers view. This is due to running animations, timers, etc.. The C++ objects map their complex internal state set to the much simpler external state set. This is the main reason that some features that level authors request can not be provided in the Lua API.

4.4 The Lifecycle of a Level

Snapshot Levelloading, Initialization, Runtime Callbacks, Ending Conditions - the mystery of Oxyds and Meditation

4.4.1 Library Preloading

4.4.2 Snapshot Principle

Most levels contain objects that take influence on each other. A switch might toggle a door by Section 4.3.2 [Target - Action], page 54, marbles may press a trigger, or a laser might activate a laserswitch or transform a hammer into a sword. Of course it is essential to know how to set up such objects to get the desired start configuration without the objects changing unexpected on level initialization.

The snapshot principle is a simple thumb rule that you can rely on in describing the level as a snapshot of object at a given point of time. Every object has just to be configured as it should be at the given time. All interactions that would take place in a running game do not take place while setting objects during initialization.

E.g. if a switch toggles a door and the switch should be initially on and the door should be initially open you describe the object with exactly these attributes:

```
{"st_switch", target="mydoor", state=ON}
{"st_door", name="mydoor", state=OPEN}
```

A laser that is initially on that illuminates a laserswitch needs an initially active laserswitch. But of course no attribute exists that would allow you to set a laserswitch active. The snapshot principle includes the rule that all internal states are updated without external actions. This means that the laserswitch will show up active without causing an action on its target.

```
{"st_laser", state=ON}
{"st_laserswitch", target="mydoor"}
```

What about objects that transform on laser light. The snapshot principle keeps the object from transforming during initialization. A hammer that is set in an initially existing laser beam will not transform to a sword. It remains as a hammer that will transform on any subsequent new laser light during the game.

Of course it cannot be allowed to describe impossible initial level states. Objects like dynamite do explode immediately on a laser beam hit. Thus a dynamite item in an initial laser beam is a fault that causes an exception. The snapshot principle forces you in this case to set an explosion item instead of the dynamite.

Some objects do process internal state transformations that cannot be configured by attributes. But some of these states may be of interest on describing a snapshot of a level. Where possible a special object subkind exists with a suffix of '`_new`'. These objects can be used in the initial level description to set objects in special initial states. E.g. Section 8.4.1 [it_blocker], page 209, provides such a special subkind. Note that these objects will never report their initial subkind on a kind request as they come into existence as a standard object.

4.4.3 Level Initialization

Knowing what has been preloaded and knowing exactly which objects we have to set in which state, it is time to have a look on how your level code is processed. The main issue is to guarantee that all parts referenced have been set up properly in advance.

Prior execution of the first line of your code the world exists just as an abstract handle, but not as grid array able to accept objects. Thus the first lines of code should set up all Section 6.4 [Global Attributes], page 137, deviating from their defaults. Even though many attributes can be set or changes later on and even on runtime, there are some attributes like Section 6.4.25 [ProvideExtralifes], page 144, that take only effect if being set prior world creation, or others like Section 6.4.23 [MaxOxydColor], page 143, that must be set prior their first usage. Our recommendation is to collect all global attribute settings at the very beginning of the level.

The second section of your level code should be the declaration of tiles. Being just declarations these code lines do not set objects to the world. They just depend on global attributes and may reference each other. Listing them all together in a code section makes it easy to maintain the overview and to avoid dependency conflicts.

If you use Section 13.1 [Resolvers], page 372, you should put their declarations in the next code section as they may refer to tiles and global attributes and need to be set up prior the world creation.

The central statement of every level is the Section 5.13.1 [World Creation], page 108. It sets up the world to its size and sets initial objects according to the given tile declarations to the grid array. While you are free to add and change any of these objects later on the size of the world is fixed and can not be changed.

Thus subsequent code lines should Section 5.13.5 [add], page 110, other objects, draw additional maps of objects and finalize some objects. The most common statement for such a finalization is the Section 5.13.11 [shuffleOxyd], page 114, method. It needs to know all Section 9.5.44 [st_oxyd], page 284, to be able to color and shuffle them. Another finalization may be a custom rendering of a maze, that extracts the maze shape out of the level map (see Section 13.1.5 [res.maze], page 379).

This post world creation code may well have the need of loops or even some local used functions that need to be integrated to precede. Please keep such functions near by their usage and within the same code section.

Another set of functions that you may want to add are Section 4.4.6 [Callbacks and Load Balancing], page 60. We recommend to append these functions as the last section as they are not called within the level initialization itself.

But there is one very special exception. The `postinit()` callback is called after the level initialization code has been processed and all subsequent engine internal initialization has been finished. If this function is present in a level it gets executed directly before the first mouse movement event gets processed. Thus you can rely within this function that all objects are set up in their final state. If you have need of such a postinit callback you should put it after all the level intialization code and in front of other callback functions that will be executed on subsequent events.

4.4.4 Object Transformation

During runtime some Enigma objects do transform into other successor objects, like an Section 9.5.4 [st_blocker], page 244/Section 8.4.1 [it_blocker], page 209, an Section 9.5.8 [st_brake], page 249/Section 8.3.4 [it_brake], page 187, an Section 8.3.25 [it_rubberband], page 202/Section 11.1.2 [ot_rubberband], page 330, an Section 8.3.17 [it_hammer], page 196/Section 8.3.31 [it_sword], page 206,...

Even though the successor object may have other attributes, some attributes and especially any user attributes should be maintained. In fact the objects name, its target and action attributes and all attributes starting with an underscore '_', the user attributes, are transferred to the successor object. Thus you can rely on the successor to message the same target and you can access it via its old name.

4.4.5 Named Positions

Many stones are movable and if the user can not push them, most may still be swapped. Items may be picked up by actors or be killed in a burning fire. Thus in most cases it is preferable to mark anchors or shapes in the floor. On every grid position a floor object is guaranteed and they are much more stable than other objects. But nevertheless a user may push an Section 9.5.7 [st_box], page 248, an Section 9.5.52 [st_puzzle], page 292, or other floor building stone on an Section 7.4.13 [fl_water], page 178, or Section 7.4.1 [fl_abyss], page 166. Furthermore a user may drop and ignite an Section 8.4.2 [it_bomb], page 211, that destructs the floor leaving a new Section 7.4.1 [fl_abyss], page 166. In all these cases you may lose a named anchor or an essential part of a named grid area accessible as an object group.

Thus for every named floor that gets killed its position is stored in a repository under its name. You just need to retrieve the named positions instead of the named objects if you want to get all affected floor positions.

```
ti["~"] = {"fl_water", "water#"}
...
function sweet()
    wo[po["water#*"]] = {"it_cherry"}
end
```

Note that a request for a named position will include all positions of matching named objects as well as those named positions derived from killed floors.

4.4.6 Callbacks and Load Balancing

The most flexible feature for a level author to establish an unique behaviour of his level are Section 4.3.3 [Callback Function], page 56s.

Section 4.3.2 [Target - Action], page 54, kill warning Section 11.2.2 [ot_timer], page 333, global and res.*.function

4.4.7 Level Restart

4.4.8 Ending Conditions

Two essential questions remain to be answered. When and under which conditions is a level successfully finished. How do I declare a level as being a meditation level in opposite to a standard oxyd pair opening level.

In fact there is no 'meditation' flag, neither within the XML Level Section 3.3 [Info metadata], page 28, nor as one of the Section 6.4 [Global Attributes], page 137. That means there is no formal distinction between both level 'types'. But there are two different types of ending conditions. Both are checked permanently and whichever is fulfilled first wins. Thus Enigma allows you to write true hybrid levels that provide Section 9.5.44 [st_oxyd], page 284, as well as Section 8.4.11 [it_meditation], page 219, allowing the user to solve the level by two totally different means.

The main way to end the game is to fulfill the oxyd pair opening condition:

The game is over when the user succeeds in opening all regular colored Section 9.5.44 [st_oxyd], page 284s by pairs.

This implies that there is at least one pair of regular colored oxyd stones and that all oxyd colors appear in even number of instances. Whereas you will always add at least one pair of oxyds for a standard level, you may simply loose track of the number of instances. Therefore the engine will permanently check at runtime that every oxyd color appears in an even number of instances. Any violation causes an error. In case you will add or delete oxyd stones you need to disable this checking by setting the global attribute Section 6.4.2 [AllowSingleOxyds], page 137, to `true`. Now it is your reponsibility as an author to ensure that the level remains solvable by adding or removing pairs only.

The second way to end the game is to fulfill the meditation condition:

All Section 10.2.5 [ac_pearl], page 326s must reside for at least one second within the uneven area of an Section 8.4.11 [it_meditation], page 219, all Section 8.4.11 [it_meditation], page 219, marked as `essential` must be occupied and the number of Section 10.2.5 [ac_pearl], page 326s must be equal to the number of occupied Section 8.4.11 [it_meditation], page 219s.

This implies again that there exists at least one Section 10.2.5 [ac_pearl], page 326, and that no two pearls can reside within the same Section 8.4.11 [it_meditation], page 219. There must be at least the same number of Section 8.4.11 [it_meditation], page 219, as of Section 10.2.5 [ac_pearl], page 326, but there may be more Section 8.4.11 [it_meditation], page 219s as long as they are not marked as being essential. A surplus of Section 8.4.11 [it_meditation], page 219, can easily occur due to explosions of Section 8.3.11 [it_dynamite], page 192.

A level that should be solved by fulfillment of the meditation condition can contain Section 9.5.44 [st_oxyd], page 284, and by setting Section 6.4.2 [AllowSingleOxyds], page 137, to `true` you can add odd numbers of oxyd stones of a color. On the other hand you can add Section 10.2.5 [ac_pearl], page 326, to a level that should be solved by fulfillment of the oxyd pair condition. But you must carefully check that the user can not rest the pearls in given Section 8.4.11 [it_meditation], page 219, or can create Section 8.4.11 [it_meditation], page 219, by Section 8.3.11 [it_dynamite], page 192.

Marking more Section 8.4.11 [it_meditation], page 219, as `essential` than existing Section 10.2.5 [ac_pearl], page 326s can avoid shortcuts.

A level that is set up to allow the user to fulfill both conditions is called a hybrid level. Of course it is a difficult task to provide equivalent solutions for both approaches.

Independent of the condition type all actors marked as `essential` need to be alive at the moment the condition is fulfilled. Mainly in existing legacy levels but also in some very carefully designed future levels the author may allow the user to sacrifice an actor to fulfill the condition by setting the global attribute Section 6.4.32 [SurviveFinish], page 145, to `false`. In this case a marble may shatter while the condition is fulfilled. Of course the essential actor may not shatter in advance, because as soon as the shattering is over the essential actor will cause a level restart, if it can not be resurrected.

5 Lua API

Knowing the basic principles of an Enigma level's world you now just need the language glue to write your first level. Enigma levels are written in the language Lua (`http://www.lua.org`) as of version 5.1.4. This powerful language gives you the ability to write most complex, dynamical levels, while being nearly transparent on writing basic standard levels. Indeed there is no reason to dig into this language at the very beginning.

With the second Lua API version, as of Enigma 1.10, we designed an optimized way of describing levels in a very short and readable manner. Thus we would like to introduce you to this API by giving several examples from a basic level to most thrilling dynamic real Enigma levels. You should be able to start your first experiments just after reading the first example with its explanations.

For your convenience we do color the Lua code part. Predefined Lua variables and functions are colored in green. Enigma internal string constants as object kinds, attribute or message names are colored in blue. Level specific variable names and value constants are colored in magenta.

After the examples and a short overview the details of the language specific API part are given, as you can expect it for a reference manual. Please note that additional Chapter 13 [Advanced Features], page 372, are described in a separate chapter.

5.1 Basic Lua Examples

Let us look at two basic onescreener levels, that make use of all basic techniques. While the first level is a little bit artificial, as it is designed for demo purposes only, the second one is a quite dynamic real level out of the Enigma levelpacks.

5.1.1 Basic Example

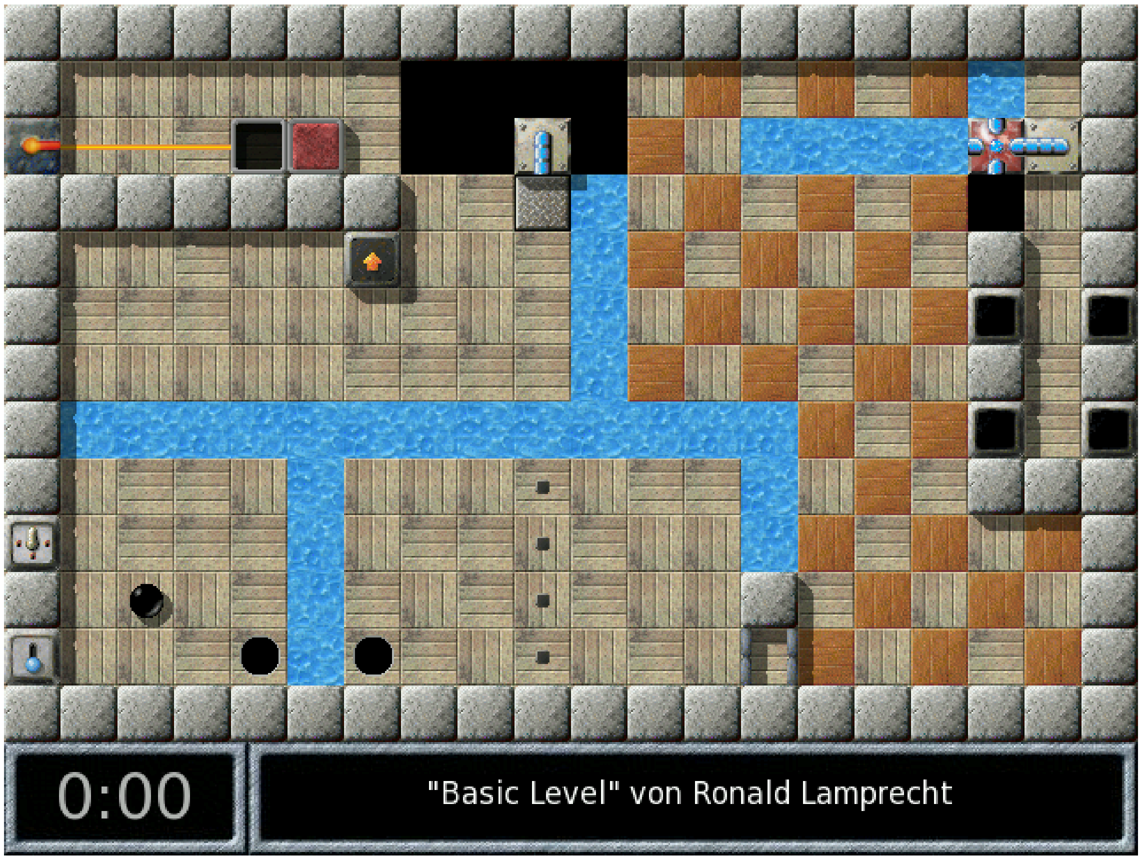
Let us view the source code. We did add a line count in the first two columns for reference purpose within this section. These line count numbers are not part of the source code itself!

```
 1    <?xml version="1.0" encoding="UTF-8" standalone="no" ?>
 2    <el:level xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLocati
 3     <el:protected>
 4       <el:info el:type="level">
 5         <el:identity el:title="Basic Level" el:subtitle="" el:id="20080721ral513"/>
 6         <el:version el:score="1" el:release="1" el:revision="$Revision: 1170 $" el:
 7         <el:author el:name="Ronald Lamprecht" el:email="ral@users.berlios.de"/>
 8         <el:copyright>Copyright © 2008 Ronald Lamprecht</el:copyright>
 9         <el:license el:type="GPL v2.0 or above" el:open="true"/>
10         <el:compatibility el:enigma="1.10"/>
11         <el:modes el:easy="true" el:single="true" el:network="false"/>
12         <el:score el:easy="-" el:difficult="-"/>
13       </el:info>
14       <el:luamain><![CDATA[
15
16    wo["ConserveLevel"] = true
17
```

```
ti[" "] = {"fl_samba"}
ti["."] = {"fl_abyss"}
ti["~"] = {"fl_water"}
ti["#"] = {"st_granite"}
ti["X"] = {"st_oxyd"}

ti["L"] = {"st_laser", orientation=EAST, state=ON}
ti["M"] = {"st_lightpassenger", interval=0.04}

ti["P"] = {"st_polarswitch", name="polar"}
ti["T"] = {"it_trigger", target="polar"}

ti["^"] = {"st_boulder", "boulder", orientation=NORTH}
ti["F"] = {"st_fourswitch", target="boulder", action="orientate"}

ti["D"] = {"st_door_d", "door", faces="ew"}
ti["B"] = {"it_blocker", "wall#"}
ti["S"] = {"st_switch", target={"door", "wall#*"}}

ti["v"] = {"it_vortex", "left", destination="right"}
ti["V"] = {"it_vortex", "right", destination="left"}

ti["O"] = {"st_turnstile", flavor="red"}
ti["E"] = {"st_turnstilearm", orientation=EAST}
ti["N"] = ti["."] .. {"st_turnstilearm_n"}

ti["+"] = {"fl_samba", checkerboard=0} .. ti({"fl_wood", checkerboard=1})

ti["1"] = {"#ac_marble"}

if wo["IsDifficult"] then
    ti["="] = ti["~"]
else
    ti["="] = ti["~"] .. {"it_strip_ew"}
end

w, h = wo(ti, " ", {
    "####################",
    "#      ....++++++~ #",
    "L   PM ..N.++~~~~OE#",
    "#######  T~++++++. #",
    "#     ^   ~++++++# #",
    "#         =++++++X X",
    "#         ~++++++# #",
    "#~~~~~~~~~~~~~+++X X",
    "#    ~   B   ~+++###",
    "F    ~   B   ~+++++#",
```

```
65          "# 1  ~   B   #++++++#",
66          "S   v~V  B   D++++++#",
67          "####################"
68      })
69
70      wo:shuffleOxyd()
71
72       ]]></el:luamain>
73          <el:i18n>
74            <el:string el:key="title">
75              <el:english el:translate="false"/>
76            </el:string>
77          </el:i18n>
78        </el:protected>
79      </el:level>
```

The resulting level looks like this in the game



Let us now analyse the code line by line.

Lines 1 to 14 are the XML metadata of the level as described in Chapter 3 [Level Basics], page 21. The only line worth mentioning is

```
10          <el:compatibility el:enigma="1.10"/>
```

You need to declare the level to be compatible to Enigma 1.10 or higher for the new API 2 as described in this reference manual. A value less than 1.10 indicates compatibility to a previous Enigma release that did use the old API 1, which should not be mixed up with the new API 2.

The Lua part starts with line 15:

```
16    wo["ConserveLevel"] = true
```

Like most levels it starts with setting Section 6.4 [Global Attributes], page 137. The handle of our world is '`wo`'. This object reference is preset (see Section 4.1.3 [World as an Object], page 47). Concerning Lua it is an '`userdata`', but most of its usage syntax is identical to that of Lua tables. Thus we access an attribute by providing the desired attribute name in square brackets. As we give a literal attribute name, we have to put it in double quotes '`"`'. In total this line requests the world to resurrect a killed actor as long as there are enough extra lifes to conserve the running level (see Section 6.4.5 [ConserveLevel], page 138). In fact '`true`' is the default value. So we could have left this line out. But remember it is a demo level.

The second part of a level are the tile definitions as explained in Section 4.1.1 [World's Shape and Coordinates], page 46. Let us start with the most simple ones:

```
18    ti[" "] = {"fl_samba"}
19    ti["."] = {"fl_abyss"}
20    ti["~"] = {"fl_water"}
21    ti["#"] = {"st_granite"}
22    ti["X"] = {"st_oxyd"}
```

Again we use a handle '`ti`' which is a preset object reference for the tile definition repository. Like the world it is a Lua '`userdata`'. And we can access it like the world by giving the desired index in square brackets. These indices are free to your choice. They have to be of a common character length if they are referenced in the world map below. For a small level one character keys are sufficient. You can use any ASCII character that Lua is aware of. That means upper and lower case characters '`A-Z,a-z`', the numbers and special characters besides backslash '`\`' and double quote '`"`'.

The assigned object definition are given as Lua anonymous tables, the curly braces, containing in the most simple case just the desired Section 4.2.1 [Object Kind], page 49. As it is again a literal string, it has to be quoted. Without any further specification the objects are taken in their default configuration as described in Chapter 7 [Floor Objects], page 148, and following chapters.

```
24    ti["L"] = {"st_laser", orientation=EAST, state=ON}
25    ti["M"] = {"st_lightpassenger", interval=0.04}
```

These two lines define objects with custom configuration. The Section 9.5.34 [st_laser], page 272, should send its beam to the east and should start being switched on. The Section 9.5.38 [st_lightpassenger], page 275, should move a little bit faster than usually. Both times we just have to add comma separated additional attributes. The attribute names are not quoted as they are followed by an equal '`=`' sign.

```
27    ti["P"] = {"st_polarswitch", name="polar"}
28    ti["T"] = {"it_trigger", target="polar"}
```

An Section 9.5.49 [st_polarswitch], page 290, named for reference usage (see Section 4.2.3 [Object Naming], page 50). The Section 8.4.18 [it_trigger], page 226, sets up a Section 4.3.2

[Target - Action], page 54, the target being our polarswitch. The action attribute is omitted. It defaults to the message '`toggle`'. Thus any actor or stone on top of the trigger makes the polarswitch transparent, but switches it back to opacity when leaving the trigger.

```
30    ti["^"] = {"st_boulder", "boulder", orientation=NORTH}
31    ti["F"] = {"st_fourswitch", target="boulder", action="orientate"}
```

Another pair of objects that are coupled by Section 4.3.2 [Target - Action], page 54. The Section 9.5.6 [st_boulder], page 246, starts trying to move to north. This time we name the object just by giving the name as the second comma separated string. We omitted the attribute identifier '`name =`'. This is a shortcut for this most common attribute which requires the name to be given as the second value directly after the object's kind.

The Section 9.5.25 [st_fourswitch], page 264, references the boulder as its target. We need to give the action as well, as we want to make use of a special action that directly steers the boulder according to the fourswitch orientation.

```
33    ti["D"] = {"st_door_d", "door", faces="ew"}
34    ti["B"] = {"it_blocker", "wall#"}
35    ti["S"] = {"st_switch", target={"door", "wall#*"}}
```

And another even more complex Section 4.3.2 [Target - Action], page 54. We want a single Section 9.5.64 [st_switch], page 307, to toggle a Section 9.5.20 [st_door], page 258, as well as set of Section 8.4.1 [it_blocker], page 209s at the same time. The gaming idea is that neither with switch on nor with switch off the marble can pass both obstacles. The gamer needs to steer the boulder through the blocker wall to pass these obstacles.

The setup of the door is simple. We just need to name it to be able to reference it later on. We want to use several blocker objects and we need to name each for reference purposes. We do this by appending a hash sign '`#`' to its name as described in Section 4.2.3 [Object Naming], page 50. Every blocker gets a unique name. The switch needs to list all these objects as its targets. This is done by an embedded anonymous table given by the curly braces and comma separated values. The first one is our door's name, the second one is a wildcarded string that describes all our blocker objects. The asterisk stands for any suffix that may have been added behind the hash in the process of autonaming of our blockers.

```
37    ti["v"] = {"it_vortex", "left", destination="right"}
38    ti["V"] = {"it_vortex", "right", destination="left"}
```

We want to use two Section 8.4.19 [it_vortex], page 227, that are connected to each other allowing the marble to warp into both directions. We set up both vortices with a unique name and add the attribute '`destination`' referencing the other vortex' name.

Note that it is no problem to reference the right vortex in line 37 while it is named later on in line 38. We are still just defining tiles and not creating any objects at all.

```
40    ti["O"] = {"st_turnstile", flavor="red"}
41    ti["E"] = {"st_turnstilearm", orientation=EAST}
42    ti["N"] = ti["."] .. {"st_turnstilearm_n"}
```

Another object group is an Section 9.5.67 [st_turnstile], page 309, cluster with one arm disconnected. The first two definitions are straight forward. But in line 42 we precede the arm's definition by another tile reference. It is the abyss tile defined in line 19. By concatenation, the two dots **..**, of a tile and an object definition we can define a new tile that is composed of both objects. In this case we define a turnstile arm on top of an abyss floor.

You may be wondering why we did not define floors for the other stone and item tiles. We make use of the tile definition in line 18 that we will declare later as the default floor for our level. Thus any tile declaration that does not provide its own floor will set this default floor.

```
44    ti["+"] = {"fl_samba", checkerboard=0} .. ti({"fl_wood", checkerboard=1})
```

Just for fun we want to provide a checkerboard floor on the right side of our level. This can be done by usage of the Section 6.1.11 [checkerboard], page 128, attribute. Again we concatenate two object definitions for a single tile. Both are floors. That means for each grid position we try to set both floor types, but just one meets the checkerboard condition and will be set.

Please notice that we did convert one of the floor object definitions to a tile definition by the function call '`ti()`'. This is necessary as Lua does not know how to concatenate two anonymous tables. One argument of the concatenation has to be a tile.

```
46    ti["1"] = {"#ac_marble"}
```

Finally we do need our marble. Unlike other objects it can be positioned anywhere within a grid. The most common position is the center of the grid. This is simply done by preceding the actor's kind by a hash sign '`#`'.

```
48    if wo["IsDifficult"] then
49        ti["="] = ti["~"]
50    else
51        ti["="] = ti["~"] .. {"it_strip_ew"}
52    end
```

We encourage every level author to provide an easy mode for the levels. This is an example how to define mode dependent tiles. Like in line 16 we access a world attribute. But this time it is a read access of Section 6.4.20 [IsDifficult], page 143. In easy mode we want an Section 8.4.16 [it_strip], page 224, on top of the water floor that allows the marble to pass and press the trigger. In difficult mode there should be no passage. Thus the special tile is identical to the water tile defined in line 20.

```
54    w, h = wo(ti, " ", {
55        "####################",
56        "#      ....++++++~ #",
57        "L   PM ..N.++~~~~OE#",
58        "#######  T~++++++. #",
59        "#     ^   ~++++++# #",
60        "#         =++++++X X",
61        "#         ~++++++# #",
62        "#~~~~~~~~~~~~~+++X X",
63        "#    ~   B   ~+++###",
64        "F    ~   B   ~+++++#",
65        "# 1  ~   B   #+++++#",
66        "S   v~V  B   D+++++#",
67        "####################"
68    })
```

After all tiles have been defined we can create our world simply by a map that uses our tile keys. The first argument is our handle '`ti`', that defines how the keys should be resolved. The second argument is the key of our default floor. The third argument is the map as a table of strings, one for every line.

The world initialization returns the width and height of our world which are calculated by the map's size.

```
wo:shuffleOxyd()
```

After the world is created and all objects are set, we can do some final postprocessing before the level starts to run. The most common task is the shuffling of the oxyds, which is just a method call of Section 5.13.11 [shuffleOxyd], page 114, to our mighty world object.

5.1.2 Colored Turnstiles

As this level is part of the Enigma levelpacks we recommend that you play the level first to get familiar with the used objects and their behaviour.

Now let us look at the essential Lua source code part of the level to understand how such an idea can be realized with the new API

```
ti[" "] = {"fl_sahara"}
ti["#"] = {"st_purplegray"}
ti["@"] = {"#ac_marble_black", "marble_black"}

ti["N"] = {"st_turnstilearm_n"}
ti["S"] = {"st_turnstilearm_s"}
ti["E"] = {"st_turnstilearm_e"}
ti["W"] = {"st_turnstilearm_w"}
ti["R"] = {"st_turnstile", action = {"open", "close"}, target = {"red#*", "green#*"}}
ti["G"] = {"st_turnstile", action = {"close", "open"}, target = {"red#*", "green#*"},
                                  flavor = "green"}
ti["r"] = {"it_blocker", "red#"} .. ti({"fl_red"})
ti["g"] = {"it_blocker", "green#"} .. ti({"fl_lawn"})

ti["O"] = {"st_oxyd", flavor = "d", oxydcolor = OXYD_GREEN}
ti["o"] = {"st_oxyd", flavor = "d", oxydcolor = OXYD_RED}

w, h = wo(ti, " ", {
 -- 01234567890123456789
   "#O#####O############",
   "#   r N g N rO##O#O#",
   "#WRE#WGE# R ####g#r#",
   "#   r N r S  r N   #",
   "#g#g#WG #g##r# REr##",
   "# # N S r    g S  gO",
   "#@g RE#g#gWGE###g###",
   "# # S   g    r N  ro",
   "#r#r#WGE#r##g#WGEg##",
   "# N r S g N  r     #",
   "#WGE# RE# RE####r#g#",
   "#   g S r S go##o#o#",
   "#o#####o############"
```

```
    })

    wo:shuffleOxyd()
```

There are just four tile definitions that do all the dynamic actions. Let us look first at the blocker item definitions:

```
    ti["r"] = {"it_blocker", "red#"} .. ti({"fl-red"})
    ti["g"] = {"it_blocker", "green#"} .. ti({"fl-leaves"})
```

All blockers on red floors are autonamed with a name being composed of the prefix '`red#`' and a unique random number being added by the engine as explained in Section 4.2.3 [Object Naming], page 50. This allows us to address all these blockers later on.

```
    ti["R"] = {"st_turnstile", action = {"open", "close"}, target = {"red#*", "green#*"}}
    ti["G"] = {"st_turnstile", action = {"close", "open"}, target = {"red#*", "green#*"},
                                         flavor = "green"}
```

Whenever the marble hits and turns an Section 9.5.67 [st_turnstile], page 309, it performs its actions on the targets. Here the author makes clever usage of multitargets and multiactions as described in Section 4.3.2 [Target - Action], page 54. On every turn of a red turnstile all objects named '`red#*`', that are all our blockers on a red floor, will be sent a message '`open`', whereas all blocks on a green floor, the second target group, receives the second action message '`close`'. It is essential to choose the '`open`', '`close`' messages instead of '`toggle`', as more than one red turnstile may be turned in sequence, but just the first red turn should "toggle" all blockers. The next toggling should occur on the first green turn following thereafter.

Hope you got the basic idea of the new API. You may well start with you first level experiments. But you should return and read the following chapters with overview and advanced examples to write even more fancy levels.

5.2 API 2 Overview

Having analysed a first level it is time get an overview of the API 2 capabilities. Let us take a task driven approach by listing the different possibilities and use cases by example.

5.2.1 Types Overview

But first we need to introduce you to the special Enigma value types besides the standard Lua types '`nil`', '`boolean`', '`string`', '`function`' and '`table`':

Types:

position: See Section 5.5 [Position], page 89
: A position within the world that can be described by an x and y coordinate.

positions: *preset variable:* **po**; See Section 5.10 [Positions Repository], page 104
: The singleton type of the repository of all named positions.

object: See Section 5.6 [Object], page 92
: An Enigma object like a stone, item, floor, other. Any object is a position, too.

group: See Section 5.7 [Group], page 96
: A list of objects.

namedobjects: *preset variable:* **no**; See Section 5.8 [NamedObjects], page 101
: The singleton type of the repository of all named objects.

default: *preset variable:* **DEFAULT**; See Section 4.2.4 [Object Attributes], page 52
: The singleton type of default values that can be used instead of Lua's '`nil`' in anonymous table tile definitions.

tile: See Section 5.11 [Tile and Object Declaration], page 106
: A description of one or several objects for a common grid position (floor, item, stone, actor)

tiles: *preset variable:* **ti**; See Section 5.12 [Tiles Repository], page 107
: The singleton type of the repository of all tile instances.

world: *preset variable:* **wo**; See Section 5.13 [World], page 108
: The singleton type of the world that contains all objects.

position list: See Section 4.4.5 [Named Positions], page 60
: A list of positions.

Please note the four handles '`po`', '`no`', '`ti`' and '`wo`'. You have noticed two of them in the previous section Section 5.1 [Basic Lua Examples], page 63. These are four variables, that are preset prior the level code gets executed.

API 2 uses mainly two character names for frequently used variables and functions to shorten the level code and to make it better readable. Authors should try to use either single characters or names that are three characters or longer for private variable names.

For the rest of this section let us assume that '`obj`' is an object reference of a stone, item or floor, which means that is of type '`object`'. And let '`pos`' be a valid variable of type '`position`'.

5.2.2 Position Tasks

For reference details see Section 5.5 [Position], page 89.

Creating Positions:

```
pos = po(7, 3)          -- using function "po()" to generate a position objec
pos = po({7, 3})         -- using a table position constant as argument
pos = obj               -- every object is a valid position
pos = po(12.3, 3.7)     -- a position within a grid (for an actor)
```

Absolute positions are created by the function '`po()`'. But the most common way should be the reinterpretation of an object as a position. This lets you set other objects relatively to given ones.

Position Constants:

```
{7,3}     -- a valid position for all arguments and operations (see
[Caveats], page 377)
```

Anonymous tables with just two number values can be used in many cases directly as a position constant. In case of errors, e.g. when operators are not well defined like addition of two constants, which results in an attempt of adding two Lua tables, use the function '`po()`' to convert the constant.

Coordinate Access:

```
x, y = pos.x, pos.y
x, y = pos["x"], pos["y"]
x, y = pos:xy()
x, y = obj.x, obj.y
x, y = obj:xy()
```

The x and y coordinate of a position or object can be read accessed like any object attribute. A position or object method call by '`xy()`' returns both coordinate values at once. You can not set a position value by coordinate write access. Objects need to be set to a new world position. New positions can be calculated by position arithmetic.

Position Calculation:

```
pos = obj + {2,7}
dpos = obj1 - obj2
dpos2 = 2 * dpos
dpos3 = dpos / 2
```

Positions can be added or subtracted to get distance vectors. You can multiply and divide them with any number.

Center positions for set actors

```
pos_centered1 = pos + {0.5, 0.5}
pos_centered2 = #pos
pos_centered3 = #obj
```

Especially for positioning of actors you sometimes need the position of the center of a grid. Of course you can get it by addition of a constant position. But the '`#`' operator applied on a position or an actor does the same in a simpler way.

Round a position to a grid

```
grid_pos = pos:grid()
grid_pos = ((pos1 - pos2)/2):grid()
```

A result of a position calculation needs sometimes to be rounded to integer grid coordinates. This is done by the '`grid()`' method.

Position comparison

```
pos_centered1 == pos_centered2
pos_centered1 ~= pos_centered2    -- Lua's inequality operator
```

Position can be easily compared to equality.

Position existence

```
pos:exists()
```

'`true`' if a position is a valid position of the world. All positions outside of the world return '`false`'.

5.2.3 Attribute Tasks

For reference details see Section 5.6 [Object], page 92.

Single Attribute Setting:

```
obj["destination"] = po(7,3)
wo["Brittleness"] = 7
```

Object attributes as well as global world attributes can be set like Lua table values. They can take values of special Enigma types like position, object or group.

Multiple Attribute Setting:

```
obj:set({target=mydoor, action="open"})
```

You can set multiple attributes on any object at once with the object's '`set()`' method. The argument is an anonymous Lua table with the attribute names as keys and assigned values of your choice.

Requesting Attributes:

```
value = obj["attr_name"]
value = wo["Brittleness"]
if wo["IsDifficult"] then ... end
```

Attributes of objects and the world can be read like Lua table key values.

Reset Attributes:

```
obj["length"] = nil       -- the default length, e.g. '1'
obj["color"]  = nil       -- delete color attribute - no color
obj["length"] = DEFAULT   -- the default length, e.g. '1'
```

Any object attribute can be reset to its default value, which is the attribute's "delete" operation, by assigning it the Lua '`nil`' or the Enigma '`DEFAULT`' value.

5.2.4 Object Tasks

For reference details see Section 5.6 [Object], page 92.

Creating Objects:

```
wo[pos]  = {"st_chess", color=WHITE, name="Atrax"}   -- on grid pos
wo[#pos] = {"ac_bug"}                  -- actor centered on grid pos
wo[pos]  = {"#ac_bug"}                 -- actor centered on grid pos
wo[pos]  = {"ac_bug", 0.3, 0.7}        -- actor with offsets to pos
wo[my_floor] = {"it_magicwand"}        -- set a wand on top of a given floor obje
wo[pos]  = ti["x"]                     -- tile based object definition
```

Besides map based object creation, that you saw in the previous basic examples, you can create new objects on any world position directly. The world takes a position, that may well be an object, as key argument. The new object is described either by an anonymous Lua table, containing the kind string as first value and additional attributes as key value pairs appended, or by a tile object.

Object Naming:

```
no["Atrax"] = obj
wo[pos] = {"st_chess", name="Atrax"}
wo[pos] = {"st_chess", "Atrax", color=WHITE}
```

As explained in Section 4.2.3 [Object Naming], page 50, the names are the only longtime valid object references. You can explicitly name an object by assigning it at the named object repository '`no`' to the name as the key. But most times you just supply the object's name as an object attribute. If you supply the name attribute as the **second** value in the anonymous table you can omit the key '`name =`' part as a common abbreviation.

Object Autonaming:

```
wo[pos] = {"st_chess", name="Atrax#"}
```

As explained in Section 4.2.3 [Object Naming], page 50, you can append a hash sign '`#`' to a name and use the resulting string for arbitrary number of similar objects. This is especially useful for building groups.

Requesting Objects:

```
obj = no["Atrax"]       -- named object retrieval from repository
obj = it(pos)
obj = it(x,y)
obj = st(pos)
obj = wo:it(pos)
my_item = it(my_floor)  -- get the item that is on top of the given floor
```

The most common way is naming objects and the requesting the '`no`' repository for the object reference. If you know the position of the desired object you can use one of the functions or world methods '`fl`', '`it`', '`st`' that take a position, an object as position, or just the two coordinates as arguments. Especially requesting one type of objects that is positioned at the same grid as another object, the stone on top of a floor, etc. can be very useful.

Killing Objects:

```
wo[pos] = {"it_nil"}
obj:kill()
```

You remove an object by setting another replacement object at the same position in the same layer. If you do not want to set a new object you can use the placebo objects '`fl_nil`', '`it_nil`', '`st_nil`'. Another way is to call the '`kill()`' method of an object or send it a '`kill`' message. You can only remove objects that are set on the grid. Neither actors nor owned objects like items in a players inventory can be killed - they will simply ignore the attempt.

Comparing Objects

```
obj1 == obj2
obj1 ~= obj2
```

Objects can be directly compared on equality or inequality. It is an identity comparison that acknowledges that you have two references of the same object.

Existence of an object

```
obj:exists()
-obj                 -- unary minus operator on object
if -obj then ...
```

Object references may get invalid due to objects being killed. In most cases this creates no problem as requests to invalid objects will simply be ignored. But if the level logic depends on the existence of an object you can call the '`exists()`' method or simply precede the reference by the unary minus '`-`' operator. Both ways return a simple bool value stating if the object reference is still valid.

Messages:

```
my_boulder:message("orientate", WEST)
my_boulder:orientate(EAST)
my_door:open()
```

Section 4.3.1 [Messages], page 54, are a main feature of Enigma. You can send them directly to any object by the '`message()`' method or by using any message directly as a method call itself.

Object Classification:

```
obj:is("st_chess")
obj:is("st")
obj:is("st_chess_black")
```

You create objects by giving an Section 4.2.1 [Object Kind], page 49. Later on you can check a given object for conformity to a given class or kind. Even though you can not create abstract kind objects like '`st`', you can check this way if an object is a stone. Checking for special subkinds may even evaluate the current state or other attributes of an object to report its current classification.

5.2.5 Group Tasks

For reference details see Section 5.7 [Group], page 96.

Creating Groups:

```
group = no["Atrax#*"]           -- a group of all matching objects
        --   wildcards "*","?" allowed
group = grp(obj1, obj2, obj3)
group = grp({obj1, obj2, obj3})  -- a group of objects set up in a table
```

Requesting objects from the named object repository will result in a group of objects if you make proper usage of wildcards. Appending an asterisk '`*`' to the autonaming hash will retrieve all objects that have been set with this name suffix. But you can create a group by the '`grp`' function, too. Simply add the desired object reference as arguments, either single or as a table.

Group Usage:

```
floor_group["friction"] = 3.2      -- set attribute on all floors in the group
door_group:message("open")
door_group:open()
stone_group:kill()
wo[floor_group] = {"it_coin_m"}   -- add some money on all floor positions

wo[pos] = {"st_switch", target=door_group, action="open"}
wo[pos] = {"st_switch", target="door#*", action="close"}
```

Many object operations can be applied to groups in the same manner. The operations will be applied to all members of the group. You set attributes, send messages or call any method.

The world object takes a group as key, too. You can set objects of a given definition to many positions at once.

Another usage of groups is the application as an attribute value. E.g. you can define multiple targets by supplying a group.

Group Operations:

```
doors_lasers = doorgrp + lasergrp       -- join of two groups
lasergrp     = doors_lasers - doorgrp   -- difference of two groups
common_doors = doorgrp1 * doorgrp2      -- intersection of two groups
```

Groups offer some standard operations known from handling with sets.

Group Members:

```
count = #mygroup         -- number of objects in the group
obj   = mygroup[5]      -- 5th object of the group
obj   = mygroup[-1]     -- last object of the group
for i = 1, #mygroup do obj = mygroup[i] ... end
for obj in mygroup do ... end
```

You can access the members of a group by numbered indices. The size of a group is reported by the standard Lua hash '#' operator. If you need to iterate over the objects of a group you can write easily Lua for loops. You can either iterate with a counter or directly iterate the content objects.

Shuffled Group:

```
shuffled_group = sorted_group:shuffle()
shuffled_group = no["Atrax#*"]:shuffle()
```

Every group returns a shuffled group with the same members when receiving the message `"shuffle"`.

Sorted Group:

```
sorted_group = group:sort("linear", po(2, 1))
sorted_group = group:sort("linear")
sorted_group = group:sort("circular")
sorted_group = group:sort()
```

Sort group objects in linear order according to given direction vector, or direction determined by the first two objects. Or order objects circular around their center. If no argument is given order objects lexically.

Subset Group:

```
sub_group = group:sub(2)   -- first two objects
sub_group = group:sub(-2)  -- last two objects
sub_group = group:sub(2, 4) -- objects from 2 to 4
sub_group = group:sub(2, -2) -- two objects starting with 2
```

Build subgroup with given indices and numbers.

Nearest Object:

```
object = group:nearest(reference)
```

Search object in group that is nearest to the given reference object.

5.2.6 Tiles and World Tasks

For reference details see Section 5.11 [Tile and Object Declaration], page 106, Section 5.12 [Tiles Repository], page 107, and Section 5.13 [World], page 108.

Tiles:

```
ti["_"] = {"fl_sahara"}
ti["__"] = {"fl_sahara"}
ti[".."] = {"fl_sand"}
ti["##"] = {"st_blocker"}
ti["switch_template"] = {"st_switch"}
ti[".."] = {"fl_abyss"}   -- redefinition causes error to avoid common mistake
ti[".w"] = ti[".."] .. {"it_magicwand"}
ti[" w"] = {"fl_abyss"} .. ti({"it_magicwand"})
```

The tiles repository '`ti`' is like a table, but specialized on storage of tile definitions. You can use any string as key. You can store the same definition twice at different keys. But you are not allowed to redefine an already set key. This is pure protection of common error situations. A definition stored in the repository can be used in other definitions that follow. Referencing a tile's repository entry at a given key like '`ti[".."]`' results in a tile value. Such tile values can be concatenated by the '`..`' operator with other tile values and anonymous tables containing object definitions. The last example is a concatenation of two prior not declared object definitions. You can not concatenate two anonymous tables. Lua forbids that. By converting any of the two tables by the '`ti()`' to a tile value the concatenation gets valid.

World Initialization

```
width, height = wo(ti, "__", { -- second arg: default tile key that█
"##__......",                  --   defines the base, too - this example█
"##..__.w__",                  --   is 2 chars per tile/grid
"##.. w__.."
})
```

The world is initialized by the '`wo()`' call that is explained in details at Section 5.13.1 [World Creation], page 108. In the simple form you supply the '`ti`' handle as the first argument. The second argument is the key of the default tile definition that defines the default floor to be set if a tile does not contain another floor object. At the same time this key defines by its length the standard key length as used in the following map, too. The third argument is the map given as an anonymous table of strings. The world's size is given by the maximum line length and the number of lines. These values are returned by the call.

5.2.7 Named Positions Tasks

For reference details see Section 5.9 [PositionList], page 102.

Named Position Usage:

```
obj["name"] = "anchor1"
obj:kill()
```

```
pos = po["anchor1"]
po["anchor2"] = pos
```

The position of any named object can be directly retrieved. The position is still accessible under the name, when the object gets killed. You can additionally name own positions. Note that the position of an existing object precedes a position stored under the same name.

Creating Position Lists:

```
polist = po["deepwater#*"]
polist = po(grp)
```

Requesting positions will result in a list of positions if you make proper usage of wildcards. A given object group can be converted into a position list, too.

Position List Usage:

```
wo[polist] = ti["x"]
grp = fl(polist)
```

You can use a list of positions to set tiles or to retrieve a group of floors, items, stones.

Position List Operations:

```
wo[polist .. po["beach#*"]] = {"it_banana"}
```

Two position lists can be appended. Single positions can be appended to a given position list, too.

Position List Members:

```
for i = 1, #polist do
    wo[polist[i]] = {"it_cherry"}
end
```

Single positions within the list can be accessed by index. The whole list can be traversed by a simple for loop. The hash length operator reports the number of contained positions.

5.3 Advanced Lua Examples

Now it is time to reveal the real power of the new API. Let us look again at two real levels. Investigate the levels first by playing and then join in the line by line commentary of the source code to understand how to implement your own level ideas.

5.3.1 Color Maze

Let us view the Lua source code part. We did add a line count in the first two columns for reference purpose within this section. These line count numbers are not part of the source code itself!

```
01    wo["ConserveLevel"] = false
02    wo["FollowGrid"] = false
03    wo["FollowMethod"] = FOLLOW_SCROLL
04
05    ti[" "] = {"fl_fake_abyss"} .. ti({"st_lightglass"})
06
```

```
ti["!"] = {"fl_blueslab", "blue#", _color="blue"}
ti["@"] = {"fl_pinkbumps", "orange#", _color="orange"}
ti["#"] = {"fl_redslab", "red#", _color="red"}
ti["$"] = {"fl_lawn_b", "green#", _color="green"}

ti["b"] = ti["!"] .. {"st_door", flavor="d", faces="ns", state=OPEN}
ti["B"] = ti["!"] .. {"st_door", flavor="d", faces="ew", state=OPEN}
ti["o"] = ti["@"] .. {"st_door", flavor="d", faces="ns", state=OPEN}
ti["O"] = ti["@"] .. {"st_door", flavor="d", faces="ew", state=OPEN}
ti["r"] = ti["#"] .. {"st_door", flavor="d", faces="ns", state=OPEN}
ti["R"] = ti["#"] .. {"st_door", flavor="d", faces="ew", state=OPEN}
ti["g"] = ti["$"] .. {"st_door", flavor="d", faces="ns", state=OPEN}
ti["G"] = ti["$"] .. {"st_door", flavor="d", faces="ew", state=OPEN}

ti["d"] = {"it_document", text="text1"}
ti["5"] = ti["b"] .. ti["d"]
ti["6"] = ti["O"] .. ti["d"]
ti["7"] = ti["r"] .. ti["d"]
ti["8"] = ti["G"] .. ti["d"]

ti["x"] = {"it_sensor", invisible=true, target="gates"}
ti["*"] = ti["x"] .. {"#ac_marble_black", "me"}

ti["?"] = {"st_oxyd_a"}

wo(ti, " ", {
--      |         1    1   |2    2
--      |1   5    0    5   |0    5
       "                           ",
       " xO@OxR#RxO@OxB!BxR#RxB!Bx ", --01
       " b   r   g   g   b   g   r ",
       " !   #   $   $   !   $   # ",
       " b   r   g   g   b   g   r ",
       " xR#RxB!BxO@OxG$GxO@OxO@Ox ", --05
       " g   g   r   g   g   b   b ",
       " $   $   #   $   $   !   ! ",
       " g   g   r   g   g   b   b ",
       " xR#RxO@OxG$GxR#RxG$GxR#Rx ",
       " g   b   b   o       b   r ", --10
       " $   !   !   @       !   # ",
       " g   b   5   o   ?   b   r ", --
       " xO@OxO@6*8$Gx   xG$GxR#Rx ",
       " r   b   7   b   ?   o   o ",
       " #   !   #   !       @   @ ", --15
       " r   b   r   b       o   o ",
       " xG$GxB!BxR#RxO@OxR#RxG$Gx ",
       " g   o   o   g   g   o   b ",
54          " $   @   @   $   $   @   ! ",
55          " g   o   o   g   g   o   b ", --20
56          " xB!BxO@OxR#RxR#RxO@OxB!Bx ",
57          " o   r   g   g   b   b   g ",
58          " @   #   $   $   !   !   $ ",
59          " o   r   g   g   b   b   g ", --
60          " xR#RxB!BxB!BxR#RxO@OxR#Rx ", --25
61          "                           "} --
62   --      |         1    1   |2    2
63   --      |1   5    0    5   |0    5
64   )
65
66   last = it(no["me"])   -- the last visited sensor
67   move = 0               -- the count of link moves
68   sequence = {}          -- the sequence of the 4 colors that the user did choose
69
70   function gates(value, sender)
71       if last ~= sender then
72           local middle = last + (sender - last)/2
73           local color = fl(middle)["_color"]
74           if color == nil then return end  -- someone cheated, avoid throwing an e
75           st(no[color.."#*"]):close()
76           sequence[move%4] = color
77           if move >= 3 then
78               st(no[sequence[(move+1)%4].."#*"]):open()
79           end
80           move = move + 1
81           last = sender
82       end
83   end
```

Let us concentrate on new aspects not discussed in the previous Section 5.1 [Basic Lua Examples], page 63.

```
01   wo["ConserveLevel"] = false
02   wo["FollowGrid"] = false
03   wo["FollowMethod"] = FOLLOW_SCROLL
```

This level must forbid the user to resurrect a marble at the start position. At the same time the user should see the area around the marble as complete as possible. Thus the scroll mode needs to be set, too. All this is done by setting special Section 6.4 [Global Attributes], page 137.

```
05   ti[" "] = {"fl_fake_abyss"} .. ti({"st_lightglass"})
32   wo(ti, " ", {
```

The inaccessible areas are filled with a transparent glass on top of a black floor as defined in line 5. The world initialization uses this tile definition as the default tile. This is o.k. as it contains a floor definition. Additional objects like the glass stone will never be set on default usage.

```
07   ti["!"] = {"fl_blueslab", "blue#", _color="blue"}
```

```
ti["@"] = {"fl_pinkbumps", "orange#", _color="orange"}
ti["#"] = {"fl_redslab", "red#", _color="red"}
ti["$"] = {"fl_lawn_b", "green#", _color="green"}
```

Every floor object is autonamed for later group access purposes. Additionally every floor object sets a user attribute prefixed in its name by an underscore '`_`'. This attribute stores a string that we need later on in the callback function.

```
ti["b"] = ti["!"] .. {"st_door", flavor="d", faces="ns", state=OPEN}
ti["B"] = ti["!"] .. {"st_door", flavor="d", faces="ew", state=OPEN}
```

The doors are set without being named, as we will target them by their position.

```
ti["x"] = {"it_sensor", invisible=true, target="gates"}
```

The actors moves are detected by invisible Section 8.4.12 [it_sensor], page 221s that are positioned on any intersection. The target is the Section 4.3.3 [Callback Function], page 56, '`gates`'. The action can be omitted as the function name is a unique target.

```
last = it(no["me"])   -- the last visited sensor
```

A Lua variable that stores the last sensor visited by the marble. This is initially the sensor beneath the start position of the marble. We do get the marble by name, but do store the sensor item beneath it, that is an unnamed object.

```
move = 0                -- the count of link moves
sequence = {}           -- the sequence of the 4 colors that the user did choose
```

These are the essential variables for our algorithm. The user is free in selecting the sequence of the colored floors. We do initialize the sequence by an anonymous table that will be filled with the color names. An additional move counter will give us the current index into this table.

```
function gates(value, sender)
    if last ~= sender then
```

The callback function provides the sender, the Section 8.4.12 [it_sensor], page 221, that caused the action. It is the current sensor. As the marble can return to the last sensor, we have to check that it is a new sensor before taking any actions. A simple object comparison suffices.

```
        local middle = last + (sender - last)/2
        local color = fl(middle)["_color"]
```

We need to know the color of the floor strip that the marble did pass. We do calculate the position of the middle of this floor strip by position calculation. We simply take the middle position between the last and the current intersection. Once we have the middle position we can get the floor object and retrieve the private user attribute with the color description.

```
        if color == nil then return end  -- someone cheated, avoid throwing an e
```

In regular play we are guaranteed to get a color value. But just in case a gamer cheats he may have moved irregular without visiting neighboring sensors. Just avoid errors. The gamer can not score anyway.

```
        st(no[color.."#*"]):close()
```

Knowing the color we want to close all doors on same colored floor strips. We did autoname the floors by matching name prefixes. Thus we can retrieve all floors of a given color by concatenating the color string with the suffix '`#*`' and requesting the named object repository. As we are interested in the doors we do request the stone above every floor. We provide a group of floors and get a group of stones. Not every floor has a door on top. That does not matter as only existing objects are added to the resulting stone group. Knowing the stones we just send them all a '`close`' message.

```
76              sequence[move%4] = color
```

We need to remember the sequence of colors. We just store the color name in the table at the index given by the move count modulo 4. Yes we could limit this statement to the first four moves. But who cares? The modulo operation is simpler than a conditional expression.

```
77              if move >= 3 then
78                  st(no[sequence[(move+1)%4].."#*"]):open()
79              end
```

On the first 3 moves we just do close doors and remember the color sequence. But starting with the 4th move we need to open the next color in sequence. We do retrieve the color string of the next color from the sequence table by a simple modulo calculation. Having the color name we do the same trick as in line 75. But this time we do send the '`open`' messages to all affected doors.

```
80              move = move + 1
81              last = sender
```

Finally we just have to increase the move count and to remember the current sender as the last visited sensor.

That is all to code a quite complex dynamic level idea like "Color Maze".

5.3.2 Weirdly Wired

You should have restarted this level several times to notice the design changes of the floor pattern and the border panel stones besides the dynamic wiring of the stones.

Let us view the Lua source code part. We did add a line count in the first two columns for reference purpose within this section. These line count number are not part of the source code itself!

```
01        <el:compatibility el:enigma="1.10">
02          <el:dependency el:path="lib/libmath" el:id="lib/libmath" el:release="1" el:
03        </el:compatibility>
...
04      ti[" "] = {"fl_sahara", friction = 3.5, adhesion = 4.0}
05      ti["a"] = {"fl_ivory", friction = 3.5, adhesion = 4.0}
06      ti["b"] = {"fl_bright", friction = 3.5, adhesion = 4.0}
07      ti["c"] = {"fl_platinum", friction = 3.5, adhesion = 4.0}
08      ti["_"] = {"fl_water"}
09      ti["@"] = {"#ac_marble_black"}
10      ti["w"] = {"st_flat_movable", "wood#"}
11      ti["t"] = {"it_trigger", "trigger#"}
12      ti["d"] = {"st_blocker", "door#"}
13      ti["o"] = {"st_oxyd", oxydcolor = OXYD_YELLOW, flavor = "a"}
14      ti["O"] = {"st_oxyd", oxydcolor = OXYD_WHITE, flavor = "a"}
15      ti["1"] = {"st_panel", cluster = 1}
```

```
ti["2"] = {"st_panel", cluster = 2}
ti["S"] = {"st_switch", target = "easy_mode_call"}

floors  = {ti[" "], ti["a"], ti["b"], ti["c"]}
polynom = lib.math.random_vector(10, 4)

function myresolver(key, x, y)
  if key == " " then
    return floors[lib.math.cubic_polynomial(polynom, x, y) % (#floors) + 1]
  elseif    (key == "#")
        or ((key == "_") and (random(4) == 1))
        or ((key == "S") and wo["IsDifficult"]) then
    return ti[""..random(2)]
  else
    return ti[key]
  end
end

w, h = wo(myresolver, " ", {
 -- 01234567890123456789
   "###################____________________",
   "#                  #_____###o###_______",
   "#   w   w t   t    #_____#d   d#_______",
   "#     w   w t   t  #___### ### ###_____",
   "#  w     t         #___#d d#_#d d#_____",
   "#                  ##### ###_### ###___",
   "S    w   w t @ t        d#___#_#d d#___",
   "#                  #######_####### #___",
   "#  w     t         #_______O  d# # o___",
   "#     w   w t   t  #_______### ### #___",
   "#   w   w t   t    #_________#d   d#___",
   "#                  #_________###O###___",
   "###################____________________"
})

door_p = lib.math.permutation(12)
wire_p = lib.math.permutation(12)
woods = no["wood#*"]
triggers = no["trigger#*"]
doors = no["door#*"]

for j = 1, 12 do
  triggers[j].target = doors[door_p[j]]
end

for j = 1, 9 do
  wo:add({"ot_wire",
63               anchor1 = woods[wire_p[j + 3]],
64               anchor2 = woods[wire_p[j%3 + 1]]})
65      wo:add({"ot_wire", name = "obsolete_wire#",
66               anchor1 = woods[wire_p[j + 3]],
67               anchor2 = woods[wire_p[j%9 + 4]]})
68    end
69
70    function easy_mode_call(is_on, sender)
71      if is_on then
72        no["obsolete_wire#*"]:kill()
73      else
74        for j = 1, 9 do
75          wo:add({"ot_wire", name = "obsolete_wire#",
76                   anchor1 = woods[wire_p[j + 3]],
77                   anchor2 = woods[wire_p[j%9 + 4]]})
78        end
79      end
80    end
```

How is this versatility in design and action achieved as the last lines 69 to 79 obviously deal just with the easy mode diffs? Let us analyse the lines that do the real work.

```
01       <el:compatibility el:enigma="1.10">
02         <el:dependency el:path="lib/libmath" el:id="lib/libmath" el:release="1" el:
03       </el:compatibility>
```

We make use of some functions of the Section 12.3 [libmath], page 338, library. Thus we need to preload it, besides declaration of compatibility to Enigma 1.10.

```
04    ti[" "] = {"fl_sahara", friction = 3.5, adhesion = 4.0}
05    ti["a"] = {"fl_ivory", friction = 3.5, adhesion = 4.0}
06    ti["b"] = {"fl_bright", friction = 3.5, adhesion = 4.0}
07    ti["c"] = {"fl_platinum", friction = 3.5, adhesion = 4.0}
```

Four floor types that the dynamic floor is composed of. They all are unified in the '`friction`' and '`adhesion`' to provide smooth movement on the stylish floor.

```
10    ti["w"] = {"st_flat_movable", "wood#"}
11    ti["t"] = {"it_trigger", "trigger#"}
12    ti["d"] = {"st_blocker", "door#"}
```

The movable stone that will be wired, the target triggers and the doors to be opened. All are autonamed for group retrieval from the named object repository.

```
13    ti["o"] = {"st_oxyd", oxydcolor = OXYD_YELLOW, flavor = "a"}
14    ti["O"] = {"st_oxyd", oxydcolor = OXYD_WHITE, flavor = "a"}
```

A minor design aspect: selecting two unique colors for the Section 9.5.44 [st_oxyd], page 284s.

```
15    ti["1"] = {"st_panel", cluster = 1}
16    ti["2"] = {"st_panel", cluster = 2}
```

The base of the prominent all time different looking Section 9.4.4 [st_panel], page 241, border design. Two tiles with panel stones assigned to two different clusters. The engine will automatically join all neighboring stones of the same cluster to big unified blocks. Now we just need to assign these tiles to the different grid positions.

```
17    ti["S"] = {"st_switch", target = "easy_mode_call"}
```

The left border switch that will just be used in easy mode. It is blocked in line 27 to not appear in the regular mode. The target is the callback function of lines 71 to 81.

```
19    floors  = {ti[" "], ti["a"], ti["b"], ti["c"]}
20    polynom = lib.math.random_vector(10, 4)
```

Preparations for the floor design. The four floor tiles are stored in a table for number based index access. Ten random numbers in the range 1 to 4 are stored in a table, which we will use as polynom coefficients later on.

```
22    function myresolver(key, x, y)
34    w, h = wo(myresolver, " ", {
```

Up to now we did look up the keys used in the map from our tiles repository '`ti`' that was the first argument of the world initialization call. But now we use a Section 13.1.2 [Custom Resolver], page 373. The function starting in line 22 is called on every tile to be resolved. It has the task of delivering the appropriate tile.

```
23      if key == " " then
24        return floors[lib.math.cubic_polynomial(polynom, x, y) % (#floors) + 1]
```

These two lines generate the always changing floor design. For every map key ' ' we calculate the cubic polynomial that is randomized due to the coefficients. The resulting number is limited to the number of our four floors. This number is taken as the index into our '`floors`' table and the resulting tile definition is returned.

```
25      elseif    (key == "#")
26            or ((key == "_") and (random(4) == 1))
27            or ((key == "S") and wo["IsDifficult"]) then
28        return ti[""..random(2)]
```

And now we cluster the border panels. First we need to decide where to put panels at all. The positions marked '`#`' in the map are for sure. Additionally we choose randomly every 4th '`_`' position to be a panel instead of being a water floor. Finally we replace just in difficult mode the switch marked as '`S`' by a panel stone. Now we need to assign to this grid position one of the two panel cluster tiles. We simply generate a random number out of 1 and 2. But we do need a string as the tiles key. We force Lua to convert the number to string by concatenating an empty string '`""`' with the random number. Choosing the right panel variants to build up closed clusters is done by the engine.

```
29      else
30        return ti[key]
```

Finally for all other keys that need no special treatment we just take the tile definition as stored in the tiles repository.

```
34    w, h = wo(myresolver, " ", {
35     -- 01234567890123456789
36       "###################____________________",
37       "#                  #_____###o###_______",
38       "#   w   w t   t    #_____#d   d#_______",
39       "#     w   w t   t  #___### ### ###_____",
...
```

The map uses the keys as interpreted by the custom resolver. Thus all mandatory panel stones are marked by '#' and all may be water by '_'. All spaces ' ' do not stand for the sahara floor definition in the tiles repository, but are floor positions for our design floor set up in the custom resolver. Note that even the 'w' marked tiles will set a design floor, as the default floor is ' ', too.

```
door_p = lib.math.permutation(12)
wire_p = lib.math.permutation(12)
```

Now let us shuffle the trigger/door assignment and the wire distribution. We do this by permuting 12 index numbers to be used for door and wire access.

```
woods = no["wood#*"]
triggers = no["trigger#*"]
doors = no["door#*"]
```

Get the groups of movable stones, triggers and doors. It is essential to do this once and to store the resulting groups as we want to index the group members. Repeated access to the named object repository does not guarantee a stable sorting of the result groups. Thus we operate on the stable once retrieved and stored groups.

```
for j = 1, 12 do
  triggers[j].target = doors[door_p[j]]
end
```

A random assignment of the triggers to the doors. Every trigger gets a random indexed member of the door group as target. Note the alternative attribute member access on the trigger. Instead of embracing the attribute's name in square brackets and quoting the string constant as '["target"]' the author did prefer to write '.target'. That is a legal Lua alternative statement as long as the attribute's name is a legal Lua name (see [Caveats], page 377).

```
for j = 1, 9 do
  wo:add({"ot_wire",
          anchor1 = woods[wire_p[j + 3]],
          anchor2 = woods[wire_p[j%3 + 1]]})
```

Finally we need to add the Section 11.1.3 [ot_wire], page 331, between our movable stones. This can not be done within the map. We need to use the Section 5.13 [World], page 108, method 'wo:add()', which takes the two connected stones as two anchor attributes. We select the first 3 stones of our wood group as stones to be connected with 3 other stones of the indices 4 to 12. Thus we take in every loop as the first anchor one of the stones 4 to 12 and connect it to one of the first 3 stones by a simple modulo operation. The first three stones now have three wires and are finished. The last 9 stones have just one wire.

```
  wo:add({"ot_wire", name = "obsolete_wire#",
          anchor1 = woods[wire_p[j + 3]],
          anchor2 = woods[wire_p[j%9 + 4]]})
end
```

Now we wire these remaining 9 stones in sequence, in a closed circle. That gives each stone 2 additional wires. We do this by connecting each of the stones 4 to 11 with its successor and finally connecting stone 12 to stone 4, what is done by the modulo operation. This completes the level for the regular mode. As preparation for the easy mode we do autoname these additional wires.

```
71    function easy_mode_call(is_on, sender)
72      if is_on then
73        no["obsolete_wire#*"]:kill()
```

Just for the easy mode we added a switch to remove and recreate the additional wires. As we named these obsolete wires we can simply kill all of them in a single call by applying the '`kill()`' method to the group of these wires.

```
73      else
74        for j = 1, 9 do
75          wo:add({"ot_wire", name = "obsolete_wire#",
76                anchor1 = woods[wire_p[j + 3]],
77                anchor2 = woods[wire_p[j%9 + 4]]})
78        end
79      end
```

When the user switches off again, the wires should be recreated. That is done by the same code as lines 65 to 68. Note that is essential that we stored and kept the used wire permutation in the variable '`wire_p`'.

5.4 Introduction to Datatypes

Before describing the datatypes in detail let us look at the used common concepts and conventions.

5.4.1 Syntax and Conventions

In the following subchapters we will describe the datatypes, their operators and methods, and global functions in detail. We need some syntax and conventions for an efficient description.

The following short names, and those derived by appending a number, do always represent a value of the corresponding type:

- pos - Section 5.5 [Position], page 89,
- obj - Section 5.6 [Object], page 92,
- polist - Section 5.9 [PositionList], page 102,
- group - Section 5.7 [Group], page 96,
- cpos - constant position, a table with two numbers like {2, 3}

On syntax descriptions of datatype operators or methods we need to list allowed argument types. Often several types are possible and you are allowed to choose any of a list. In these cases we enlist the types enclosed by '`<`' and '`>`' and separated by '`|`'. These characters are not part of the operator or method itself and should thus not be typed into the level code. Note that we keep square braces '`[`', '`]`' and curly braces '`{`', '`}`' as literal Lua symbols. When these braces appear in the syntax you need to type them in the code. E.g. the following syntax rule:

```
result = pos + <pos | obj | cpos | polist>
```

allows you to write any of the following lines in your level

```
result = pos + pos
result = pos + obj
result = pos + cpos
result = pos + polist
```

But a syntax rule like

```
x = pos["x"]
```

requires the Lua square brackets to be coded literally. Of course you are still free to name your position variable and the resulting value variable whatever you like.

5.4.2 Value and Reference

Another most important aspect of Lua data types is the difference between values and references. Values are numbers, booleans like '`true`' and '`false`', strings and '`nil`'. The only reference data type is the Lua table.

Values are always constant. They can never be modified. You assign a value to a variable. On calculations you may assign another value to the same variable. But the original value does never get modified. That should be obvious if you think of values like '`true`' or numbers like '`7`'. But it is even true for strings like `"hello"`. When you append two strings you get a new string. But the components themselves do not change. All "string modifying" methods do return a new string with the resulting value. Thus a variable containing the value of the original string still contains the unmodified value.

Tables are of a totally opposite nature. They represent data containers. In Lua you are just handling references to these containers. When you add or change a value within the container the table reference remains unmodified but the table contents changes. Thus two variables containing both references to the same table will afterwards both reference the same modified table.

We will denote for every new data type the character of being a value or a reference. If you are unfamiliar to the resulting effects you may want to read the appendix about [Caveats], page 377.

5.4.3 Polymorphism and Overloading

You may have noticed that in many operations you can use an Section 5.6 [Object], page 92, as a Section 5.5 [Position], page 89. This is due to the fact that objects support most of the position features as well. Objects are no positions, but they do speak the same language. This feature is called '`polymorphism`' and helps you to simplify your code significantly. In the following subchapters you should carefully look at the syntax to understand which types of arguments do fit in seamlessly.

The number of usable operators is limited by Lua. Thus an addition of two data by the '`+`' operator causes different actions depending on the involved data themselves. An addition of two positions results in a vectorial addition. But the addition of two groups results in a join of the groups. This reuse of a single operator is called '`overloading`'.

Overloading combined with polymorphism can cause situations that are ambiguous by design. E.g. we decided to allow the addition of a position with an object resulting in the vectorial addition of the object's position to the first one. At the same time we want to be able to join an object with an existing group by usage of the '`+`' operator. But what should be the result of an addition of two objects? The vectorial addition of their positions, or the join of both objects in a new group? Either makes sense and would be useful. In this case we decided for the first possibility as the minus operation as the vectorial difference between two objects is a very important feature. Anyway you can always force the operation of your choice to be applied by transforming one object either into a position or a group. Please read carefully the given syntax rules for a clear understanding of the results.

5.4.4 Pseudo Datatypes

Even though we introduce just the ten additional fundamental datatypes as described in the following subchapters, the API does additionally differ the same datatype according to its usage. E.g. a standard Lua number is used to describe the Section 6.1.2 [state], page 125, of an object. Just in rare occurrences the state will reflect a real number like the state of Section 11.2.1 [ot_counter], page 332. For most objects the state will just be one of a given set of allowed values, which happen to be described by numbers by the API. Thus we speak of a pseudo datatype in the case of Section 6.1.2 [state], page 125, values.

The API provides Section 6.3 [Common Constants], page 132, for all pseudo datatypes, all written in upper case letters only. You should use exclusively these constants and never their equivalent basic number or other type values. The usage of the constants makes the level code readable and upward compatible if we ever should have the need of changing the assigned values or transforming the pseudo datatype to another datatype.

There is one abstract datatype that needs to be mentioned, as it uses two different pseudo datatypes at the same time. This special case is the datatype used to describe the '`direction`' or '`orientation`'. Both are essentially the same. But we speak of '`orientation`' if we are just interested in enlisting the main directions by number values for the purpose of identification. The constant values are given as Section 6.3.5 [orientations], page 134.

Sometimes you need values for calculation of position offsets. In this case we speak of a '`direction`' and use Section 5.5 [Position], page 89, values as offset vectors. The most common values are given as constants as listed in subchapter Section 6.3.6 [direction offsets], page 134. Note that our '`direction`' values have no need of being normalized to the length of 1.

A given '`orientation`' can be transformed into a '`direction`' value by the conversion table Section 5.14.8 [ORI2DIR], page 123.

5.5 Position

A position is a Lua userdata type introduced by Enigma to handle world positions as introduced in Section 4.1.1 [World's Shape and Coordinates], page 46. A position is a value and thus constant. Once a position is created it can not be modified anymore. But you can calculate with positions by usage of operators. When you add two position values you receive the resulting position as a new value.

In contrast to Section 5.6 [Object], page 92s positions have an unlimited lifetime and will never cease to exist. Thus you can store position values in global variables and keep them as long as you need. The values are constant and will not change even if the objects from which they have been derived have meanwhile moved to another grid or even been killed.

Position values are not limited to valid world coordinates. Both coordinates can take every positive or negative number and zero, too. Thus you can calculate with positions and use them to express offsets between two other positions.

Positions are created by the Section 5.10 [Positions Repository], page 104, singleton handle, that allows you to convert coordinates, objects, position constants into positions. The handle allows you to retrieve existing named positions, too. Furtheron positions are implicitly created as return values of many operations.

For task driven samples see Section 5.2.2 [Position Tasks], page 71.

Let us look at the supported operators:

5.5.1 Position Addition and Subtraction

Syntax: result = *pos* `<+|->` `<`*pos* `|` *obj* `|` *cpos* `|` *polist*`>`

result = `<`*pos* `|` *obj* `|` *cpos* `|` *polist*`>` `<+|->` *pos*

Details: When a position is added to, or subtracted from another position or data convertible to a position the result is the position value representing the vectorial addition or difference of both arguments.

If a position is added to, or subtracted from a position list a new list is created with the positions representing the sum or difference of the position with every member of the supplied position list.

Syntax Samples:

```
newpos = po(3, 4) + {1, 2}              -- = po(4, 6)
newpos = myobject - po(1, 5)
newpolist = po(2, 3) + NEIGHBORS_4      -- po(1, 3) .. po(2, 4) .. po(3, 3)
newpolist = po["myfloor#*"] - po(3, 0)
```

5.5.2 Position Multiplication and Division

Syntax: result = *pos* `<*|/>` *number*

result = *number* `*` *pos*

Details: A scalar multiplication or division of a position vector. A position value with both coordinate values multiplicated or divided by the given number is returned.

Syntax Samples:

```
newpos = 3 * po(3, 4)   -- = po(9, 12)
newpos = po(2, 3) / 2   -- = po(1, 1.5)
```

5.5.3 Position Sign

Syntax: result = -*pos*

Details: An unary scalar multiplication of a position vector with '`-1`'. A new position value with both coordinate values multiplicated by '`-1`' is returned.

Syntax Samples:

```
newpos = -po(3, 4)   -- = po(-3, -4)
```

5.5.4 Position Center

Syntax: result = #*pos*

Details: A rounding of a position vector to the center of the grid. A new position value with coordinates of the center of the containing grid position is returned.

Syntax Samples:

```
newpos = #po(3, 4)   -- = po(3.5, 4.5)
```

5.5.5 Position Comparison

Equality and Inequality.

Syntax: result = *pos1* `<==|~=>` *pos2*

Details: A comparison of two position values. Two position values are equal if both coordinates are equal. Otherwise they are unequal. If you want to know whether two positions point to the same grid, you may want to round both position prior comparison. You can round either to the center or to the grid by usage of the position operator '`#`' or the method '`grid()`'.

Syntax Samples:

```
bool = po(3, 4) == po({3, 4})  -- = true
bool = po(3, 4) == po(4, 3)    -- = false
bool = po(3, 4) ~= po(4, 3)    -- = true
```

5.5.6 Position Concatenation

Syntax: result = *pos1* .. <*pos2* `|` *polist*>

result = <*pos1* `|` *polist*> .. *pos2*

Details: Concatenates two positions or a position with an existing Section 5.9 [PositionList], page 102, to a new PositionList containing all positions in the given order. Note that this operation is associative, that means it does not matter if you use braces in multiple concatenations or not.

Syntax Samples:

```
newpolist = po(3, 4) .. po(4, 4)
```

5.5.7 Position Coordinate Access

Syntax: result = *pos*["x"]

result = *pos*["y"]

result1, result2 = *pos*:xy()

Details: The single coordinates of a position can be read anytime. You can retrieve single coordinates by Lua square bracket index access. Of course you can use the Lua alternative dot index access syntax, too (see examples). If you want to evaluate both coordinates, you can make use of the method '`xy()`', that returns both numbers at once in a Lua multiple assignment.

Syntax Samples:

```
number = po(3, 4)["x"]           -- = 3
```

```
          number = po(3, 4).x             -- = 3
          number = po(3, 4)["y"]          -- = 4
          number = po(3, 4).y             -- = 4
          number1, number2 = po(3, 4):xy()  -- = 3, 4
```

5.5.8 Position Grid Rounding

Syntax: result = *pos*:grid()

Details: Returns a new position value that points to the upper left corner of the grid that contains the position itself.

Syntax Samples:

```
          newpos = po(3.2, 4.7):grid()    -- = 3, 4
          newpos = po(-2.4, -5.0):grid()  -- = -3, -5
```

5.5.9 Position Existence

Syntax: result = *pos*:exists()

Details: Checks if the position is part of the world and returns '`true`' if it is contained. Otherwise '`false`' is returned.

Note that the Section 5.6 [Object], page 92s '`exists`' method reports the existence of the object. Evaluation of '`po(obj):exists()`' may result in '`false`' for existing objects. E.g. this result occurs for Chapter 8 [Item Objects], page 182, currently being part of a player's inventory. The item exists, but is not part of the world. But items contained in a bag placed in the world will report the same position as the bag.

Syntax Samples:

```
          boolean = po(3.2, 4.7):exists()
```

5.6 Object

This datatype handles all world participating objects as described in Section 4.1.2 [Object Layers], page 47. When you request an object you get a reference to this object and not the object itself. You can modify the object, but the object can be modified by user actions, too. Deleting your reference by assigning another value to your variable does not delete the object itself.

On the other hand an object can cease to exist due to user actions while you still have a reference assigned to a Lua variable. Of course this reference gets invalid when the referenced object is deleted. But such an invalid reference, which we call a '`NULL`' reference, is no longer fatal with the new API. Any write accesses on such references are simply ignored. Thus you can send messages to object references independently of their validity. Just on read accesses you may want to prior check the existence of an object as you would get '`nil`' values on access of '`NULL`' references.

Objects take attributes that you access by Lua index methods. Additional to the object specific attributes you are free to store your own custom attributes on any object. Custom attributes are any indices starting with an underscore '`_`' as prefix to their name.

The real world objects are created by assigning a tile declaration to a Section 5.13 [World], page 108, position. You retrieve a corresponding object reference either by the Section 5.8 [NamedObjects], page 101, repository, by Section 5.14 [Functions], page 118, or other methods that return single object references.

Objects provide most methods of a Section 5.5 [Position], page 89, and can in most cases be directly used as a position without explicit conversion. Just special methods like existence differ on both datatypes. Of course all objects placed in the world are limited to positions within the world. But be aware that portable Chapter 8 [Item Objects], page 182, can well be part of a player's inventory and thus report a position outside of the world. Actors will always report positions rounded to the containing grid. This feature is legacy. As Lua code is anyway inappropriate to handle actor movements we maintained this rounding feature.

Objects support standard set operators of Section 5.7 [Group], page 96s, too, as long as one operand is a group and the other an object.

For task driven samples see Section 5.2.4 [Object Tasks], page 73, and Section 5.2.3 [Attribute Tasks], page 73.

5.6.1 Object Attribute Access

Syntax: result = *obj*["attributename"]

obj["attributename"] = value

obj:set({attributename1=value1, attributename2=value2,...})

Details: Read or write object attributes as described in the following chapters or custom attributes. The '`set`' method allows you to set multiple attributes at once. Attribute writes are ignored if the object reference is invalid. Attribute reads require a valid object reference. Otherwise they return '`nil`'.

Syntax Samples:

```
value = obj["color"]
value = obj.color
obj["color"] = BLACK
obj.color = BLACK
obj:set({target=mydoor, action="open"})
```

5.6.2 Object Messaging

Syntax: result = *obj*:message("msg", value)

result = *obj*:msg(value)

Details: Send a message with a given value or '`nil`' to the object. Every message can be sent directly as a method with the given message name. When the object reference is invalid the message is simply ignored.

Syntax Samples:

```
value = obj:message("open")
value = obj:open()
value = obj:message("signal", 1)
value = obj:signal(1)
```

5.6.3 Object Comparison

Syntax: result = *obj1* `<==|~=>` *obj2*

Details: A comparison of two object values. Two object values are equal if both reference the same, still existing world object. Otherwise they are unequal.

Syntax Samples:

```
bool = obj1 == obj1  -- = true
bool = obj1 == obj2  -- = false, if two different objects
bool = obj1 ~= obj2  -- = true, if two different objects
```

5.6.4 Object Existence

Syntax: result = -*obj*

result = *obj*:exists()

Details: Checks whether an object reference is still valid. Returns true if the object still exists, otherwise false is returned for '`NULL`' object references.

Syntax Samples:

```
bool = -obj
bool = obj:exists()
```

5.6.5 Object Kill

Syntax: *obj*:kill()

Details: Kills the object at once. Note that you should never kill a sender object within a callback action. If you have need of killing the sender then add the attribute Section 6.1.6 [safeaction], page 127, as explained in Section 4.3.2 [Target - Action], page 54.

Syntax Samples:

```
obj:kill()
```

5.6.6 Object Kind Check

Syntax: result = *obj*:is("kind")

result = *obj*:kind()

Details: These methods allow you to check or retrieve the Section 4.2.1 [Object Kind], page 49.

Syntax Samples:

```
bool = obj:is("st_chess")
string = obj:kind()
```

5.6.7 Object Coordinate Access

Syntax: result = *obj*["x"]

result = *obj*["y"]

result1, result2 = *obj*:xy()

Details: The single position coordinates of an object can be read anytime. You can retrieve single coordinates by Lua square bracket index access. Of course you can use the Lua alternative dot index access syntax, too (see examples). If you want to evaluate both coordinates, you can make use of the method '`xy()`', that returns both numbers at once in a Lua multiple assignment. Anyway the coordinates of an object are read only. You can not reposition an object by changing its coordinates.

Syntax Samples:

```
number = obj["x"]
number = obj.x
number = obj["y"]
number = obj.y
number1, number2 = obj:xy()
```

5.6.8 Object Addition and Subtraction

Syntax: result = *obj* `<+|->` `<`*pos* `|` *obj* `|` *cpos* `|` *polist*`>`

result = `<`*pos* `|` *obj* `|` *cpos* `|` *polist*`>` `<+|->` *obj*

Details: When an object is added to or subtracted from another position or data convertible to a position the result is the position value representing the vectorial addition or difference of both positions.

If an object is added to or subtracted from a position list a new list is created with the positions representing the sum or difference of the position with every member of the supplied position list.

Syntax Samples:

```
newpos = obj + {1, 2}
newpos = myobject - obj
newpolist = obj + NEIGHBORS_4
newpolist = po["myfloor#*"] - obj
```

5.6.9 Object Center

Syntax: result = #*obj*

Details: A rounding of an objects' position vector to the center of the grid. A new position value with coordinates of the center of the containing grid position is returned.

Syntax Samples:

```
newpos = #obj   -- e.g. po(3.5, 4.5)
```

5.6.10 Object Join

Syntax: result = *obj* `+` *group*

result = *group* `+` *obj*

Details: A new set containing the objects of the group plus the single object is returned. The object sequence is maintained. If the object is already member of the group the new group will contain just one object reference, namely the first one in sequence.

Syntax Samples:

```
newgroup = obj1 + grp(obj2, obj3, obj1)   -- = grp(obj1, obj2, obj3)
newgroup = grp(obj2, obj3) + obj1         -- = grp(obj2, obj3, obj1)
```

5.6.11 Object Intersection

Syntax: result = *obj* * *group*

result = *group* * *obj*

Details: A new set containing just the object itself, in case it is part of the group, too, or an empty group returned.

Syntax Samples:

```
newgroup = obj1 * grp(obj1, obj2)  -- = grp(obj1)
newgroup = grp(obj2) * obj1         -- = grp()
```

5.6.12 Object Difference

Syntax: result = *obj* - *group*

result = *group* - *obj*

Details: In the first case a new set containing just the object itself, if it is not part of the group, too, or an empty group returned. In the second case the new group contains all members of the old group without the object. The sequence of objects remains untouched.

Syntax Samples:

```
newgroup = obj1 - grp(obj2, obj1)  -- = grp()
newgroup = grp(obj1, obj2) - obj1  -- = grp(obj2)
```

5.6.13 Object Sound

Syntax: result = *obj*:sound("name", volume)

Details: Play a sound of given name at the position of the object. The volume defaults to '1'.

Syntax Samples:

```
obj:sound("quake")
obj:sound("quake", 2)
```

5.7 Group

A group is a sorted set of Section 5.6 [Object], page 92s. Every object can be contained just in one instance in the group. In contrast to a Lua table the group is a constant value datatype. Once you retrieved a group it can not be modified. But you can calculate and apply operators like join, intersection and difference on groups and generate thereby other group values as results.

Even though groups as values are long living you should be careful in keeping a group longer than a callback evaluation. Groups contain object references and objects can be killed. Thus a prior retrieved group may contain invalid object references on a subsequent callback evaluation. This may be uncritical if you just send a message to a group, but in other cases you may need to clean the group from invalid members (see below).

You create a group by listing the contained objects as arguments to the '`grp()`' Section 5.14 [Functions], page 118, by retrieving objects from the Section 5.8 [NamedObjects], page 101, repository or as result of other methods and calculations.

As groups are constant the sequence of contained objects is stable. All operations that generate resulting new groups maintain this sequence as far as possible. E.g. a join of two groups takes the objects of the first group in the given sequence and appends the additional objects of the second group in the sequence they appear in the second group.

All group operations that return new groups clean their results from any meanwhile invalid '`NULL`' object references. You can use this feature to clean a group by the function '`grp()`'.

Any message sent to a group will be forwarded to all its members in sequence. An attribute write access to a group results in series of attribute writes on every group member in sequence, too.

But of course you can iterate over a group and access every member by index access. Several special methods for common group evaluations like shuffling, subgroup, sort, etc. are supported, too.

For task driven samples see Section 5.2.5 [Group Tasks], page 75.

5.7.1 Group Messaging

Syntax: result = *group*:message("msg", value)

result = *group*:msg(value)

Details: Send a message with a given value or '`nil`' to all objects in the group. Every message can be sent directly as a method with the given message name. When an object reference is invalid the message is simply ignored. The result is the return value of the message to the last object in the group, or '`nil`' for an empty group.

You are even allowed to send a '`kill()`' message to all objects in a group. The objects will be killed, but the group remains filled with invalid '`NULL`' object references.

Syntax Samples:

```
value = group:message("open")
value = group:open()
value = group:message("signal", 1)
value = group:signal(1)
value = group:kill()
```

5.7.2 Group Attribute Write

Syntax: *group*["attributename"] = value

group:set({attributename1=value1, attributename2=value2,...})

Details: Set attributes as described in the following chapters or custom attributes on all objects of the group. The '`set`' method allows you to set multiple attributes at once. Attribute writes are ignored if an object reference is invalid. Attribute read on groups in not allowed - the group index read is overloaded as a group member access.

Syntax Samples:

```
group["color"] = BLACK
group.color = BLACK
group:set({target=mydoor, action="open"})
```

5.7.3 Group Comparison

Syntax: result = *group1* `<==|~=>` *group2*

Details: A comparison of two groups. Two groups are equal if both contain the same set of objects independent of their sequence within both groups. Otherwise they are unequal.

Syntax Samples:

```
bool = grp(obj1, obj2) == grp(obj2, obj1)  -- = true
bool = grp(obj1, obj2) == grp(obj1, obj3)  -- = false, if different object c
bool = grp(obj1) ~= grp(obj2, obj1)        -- = true, if different object co
```

5.7.4 Group Length

Syntax: result = #*group*

Details: Number of objects contained in the group. Invalid '`NULL`' object references are counted, too.

Syntax Samples:

```
number = #grp(obj1, obj2)        -- = 2
for i = 1, #group do obj = group[i] ... end
```

5.7.5 Group Member Access

Syntax: result = *group*[*index*]

result = *group*[*obj*]

Details: An index like read access with an index number between 1 and #*group* returns the object in the related group sequence position. Negative indices between -#*group* and -1 give the same objects. Thus you can always access the last object at index -1. All other index positions return an invalid '`NULL`' object - not '`nil`' as tables do! Thus you are always able to send messages to returned object references.

An index like read access with an object as index returns the sequence position number, the number index, of the object if it is contained in the group or '`nil`' if it is not contained.

Syntax Samples:

```
object = grp(obj1, obj2)[2]     -- = obj2
object = grp(obj1, obj2)[-1]    -- = obj2
object = grp(obj1, obj2)[0]     -- = NULL object
for i = 1, #group do obj = group[i] ... end
number = grp(obj1, obj2)[obj2]  -- = 2
number = grp(obj1, obj2)[obj3]  -- = nil
```

5.7.6 Group Loop

Syntax: for *obj* in *group* do ... end

Details: Looping over all objects contained in a group. The loop occurs in the sequence of the contained objects and includes all objects, even invalid 'NULL' object references.

Syntax Samples:

```
for obj in group do obj:toggle() end
```

5.7.7 Group Join

Syntax: result = *group* + <*obj* | *group*>

result = <*obj* | *group*> + *group*

Details: A new set containing any object of both arguments just once, is returned. The object sequence is maintained. If an object is member of both arguments the new group will contain just one object reference, namely the first one in sequence.

Syntax Samples:

```
newgroup = obj1 + grp(obj2, obj3, obj1)   -- = grp(obj1, obj2, obj3)
newgroup = grp(obj2, obj3) + grp(obj1, obj3)   -- = grp(obj2, obj3, obj1)
```

5.7.8 Group Intersection

Syntax: result = <*obj* | *group*> * *group*

result = *group* * <*obj* | *group*>

Details: A new set containing just those objects that are contained in both arguments. The objects are returned in the same sequence as they appear in the first argument.

Syntax Samples:

```
newgroup = obj1 * grp(obj2, obj1)  -- = grp(obj1)
newgroup = grp(obj1, obj2) * grp(obj2, obj1, obj3)  -- = grp(obj1, obj2)
```

5.7.9 Group Difference

Syntax: result = <*obj* | *group*> - *group*

result = *group* - <*obj* | *group*>

Details: A new set containing just those objects of the first argument, that are not contained in the second argument is returned. The sequence of the objects in the new group is the same as in the first argument.

Syntax Samples:

```
newgroup = obj1 - grp(obj2, obj1)  -- = grp()
newgroup = grp(obj1, obj2, obj3) - grp(obj2, obj4)  -- = grp(obj1, obj3)
```

5.7.10 Group Shuffle

Syntax: result = *group*:shuffle()

Details: Returns a new group with the same objects in another random sequence. Note that all invalid '`NULL`' object references are removed in the resulting group by this method call.

Syntax Samples:

```
newgroup = grp(obj1, obj2)
```

5.7.11 Group Sorting

Syntax: result = *group*:sort("circular")

result = *group*:sort("linear" <, *direction*>)

result = *group*:sort()

Details: Returns a new group with the same objects in another sorted sequence. Note that all invalid '`NULL`' object references are removed in the resulting group by this method call.

With a string argument `"circular"` the objects are arranged around their center by their angle. The distance from this center has no influence.

With a string argument `"linear"` the objects are arranged in a linear fashion. You either supply a Section 5.5 [Position], page 89, as sorting direction vector, or the first two objects of the group will define the sorting direction as default.

If no sorting argument is supplied the objects will be sorted by their name in lexical order.

Syntax Samples:

```
newgroup = grp(obj1, obj2, obj3):sort("linear", po(2,1))
newgroup = grp(obj1, obj2, obj3):sort("circular")
newgroup = grp(obj1, obj2, obj3):sort()
```

5.7.12 Group Subset

Syntax: result = *group*:sub(*number*)

result = *group*:sub(*start*, *end*)

result = *group*:sub(*start*, -*number*)

Details: Returns a new group with a subset of the contained objects. The sequence of objects in the new group is identical to the sequence in the originating group. Note that all invalid '`NULL`' object references are removed in the resulting group by this method call after determination of the subset candidate objects.

With a number as argument you determine the number of requested objects. A positive number returns the amount of objects starting with the first object of the group. Whereas a negative number returns objects from the tail of the group. In this case the absolute value determines the number of selected objects counted backwards from the last one in sequence.

With two positive numbers as arguments you define the first and the last sequence index of the requested subset.

With two numbers, but the second one being negative, you define the first object with the first number and with the absolute value of the second number you define the amount of objects you want in your subset.

Syntax Samples:

```
newgroup = grp(obj1, obj2, obj3, obj4):sub(2)     -- = grp(obj1, obj2)
newgroup = grp(obj1, obj2, obj3, obj4):sub(-2)    -- = grp(obj3, obj4)
newgroup = grp(obj1, obj2, obj3, obj4):sub(2, 4)  -- = grp(obj2, obj3, obj4)
newgroup = grp(obj1, obj2, obj3, obj4):sub(2, -2) -- = grp(obj2, obj3)
```

5.7.13 Group Nearest Object

Syntax: result = *group*:nearest(*obj*)

Details: Returns the object contained in the group that is nearest to the given reference object. The distances are calculated exactly without rounding actor positions. In case two objects have the same distance from the reference object one is chosen by chance as the result.

Syntax Samples:

```
newobject = grp(obj1, obj2, obj3):nearest(obj4)
```

5.8 NamedObjects

The datatype NamedObjects is used by just one object, the singleton repository of named objects. Whenever you name an object, see Section 4.2.3 [Object Naming], page 50, this repository registers its name and allows you to retrieve the object lateron by providing its name.

Being a singleton you can not create new NamedObjects. The singleton is stored at the global variable '`no`' on level load.

5.8.1 NamedObjects Repository Request

Syntax: result = no["*name*"]

Details: Request of one or several objects from the repository. If no wildcard characters are used in the name an Section 5.6 [Object], page 92, value is returned. It is either the unique object with the given name, or an invalid '`NULL`' object if no object exists with the given name.

If the requested name contains a wildcard character, either an asterisk '`*`' or a question mark '`?`', a Section 5.7 [Group], page 96, containing all objects with matching names is returned. An asterisk matches zero, one or several arbitrary characters. A question mark matches a single arbitrary character. Both wildcard characters can be used anywhere in the string and in arbitrary multiplicity. Anyway the result is always returned as a Section 5.7 [Group], page 96. The group may contain multiple objects, just a single object, or even no objects at all when no existing object matches your name pattern.

Syntax Samples:

```
obj = no["mydoor"]        -- exact name match
group = no["mydoors#*"]   -- any suffix
group = no["mydoor?"]     -- just one char suffix
group = no["mydoors?#*"] -- matches e.g. "mydoorsA#123435", "mydoorsB#1213"
```

5.8.2 NamedObjects Object Naming

Syntax: no["*name*"] = *obj*

Details: Index write accesses to the singleton allow you to name or rename objects. Note that you can name or rename objects by Section 5.6 [Object], page 92, attribute writes, too. The object's name is stored as attribute `"name"`. Both ways of naming an object are totally equivalent.

Syntax Samples:

```
no["myobject"] = obj
```

5.9 PositionList

A PositionList is a sorted set, known as list, of Section 5.5 [Position], page 89s. Like a Section 5.7 [Group], page 96, this container is a constant datatype, that can not be modified. But you can easily compose new position lists by concatenation of existing lists and single positions.

An important difference to a group is the ability of a position list to store a position multiple times at different locations in its sequence. Thus a position list is suited to describe paths, even paths that are closed or cross itself.

As Section 5.5 [Position], page 89s are values that never become invalid, position lists once created will never change or get invalid. They are true values themselves. Thus they are the containers of choice for longterm storage.

You can easily create a position list by Section 5.10.4 [PositionList Conversion], page 105, which is featured by the Section 5.10 [Positions Repository], page 104, singleton and allows you to transform a group into a position list by the simple expression '`po(group)`'. On the other hand you can retrieve all Section 5.6 [Object], page 92s of a basic kind located along a position list path by Section 5.14 [Functions], page 118, like '`st(polist)`', '`it(polist)`' and '`fl(polist)`'.

As a unique floor object is guaranteed to be on every grid position, you can convert a given list of unique grid positions to a group of floors without loosing any information. Now you can apply all group methods on the floors, like shuffling, sorting, subgrouping, etc.. Finally you can convert the resulting group back to a persistent position list. Of course the conversions preserve the sequence of members.

Some additional position specific operators are supplied to allow simple translations and stretchings of position lists.

Note that in contrast to a Section 5.7 [Group], page 96, this datatype can not directly be stored in an Section 5.6 [Object], page 92, attribute. But you can always store a Section 5.7 [Group], page 96, of floors in an attribute. In case floors can be destroyed you may need to name these floors as discussed in Section 4.4.5 [Named Positions], page 60.

For task driven samples see Section 5.2.7 [Named Positions Tasks], page 77.

5.9.1 PositionList Comparison

Syntax: result = *polist1* `<==|~=>` *polist2*

Details: A comparison of two position lists. Two position lists are equal if both contain the same positions in the identical sequence. Otherwise they are unequal.

Syntax Samples:

```
bool = (po(2,3).. po(5,7)) == (po(2,3) .. po(5,7))  -- = true
bool = (po(2,3).. po(5,7)) == (po(4,0) .. po(5,7))  -- = false, different po
bool = (po(2,3).. po(5,7)) == (po(5,7) .. po(2,3))  -- = false, different se
```

5.9.2 PositionList Length

Syntax: result = #*polist*

Details: Number of positions contained in the list.

Syntax Samples:

```
number = #(po(2,3) .. po(5,7)) -- = 2
for i = 1, #polist do pos = polist[i] ... end
```

5.9.3 PositionList Member Access

Syntax: result = *group*[*index*]

Details: An index like read access with an index number between 1 and #*polist* returns the position in the related position list position. Negative indices between -#*polist* and -1 give the same positions. Thus you can always access the last position at index -1. All other indices return a Lua '`nil`' value like tables.

Syntax Samples:

```
pos = (po(2,3) .. po(5,7))[2]     -- = po(5,7)
pos = (po(2,3) .. po(5,7))[-1]    -- = po(5,7)
pos = (po(2,3) .. po(5,7))[0]     -- = nil
for i = 1, #polist do pos = polist[i] ... end
```

5.9.4 PositionList Concatenation

Syntax: result = *polist1* .. `<`*pos* `|` *polist2*`>`

result = `<`*pos* `|` *polist1*`>` .. *polist2*

Details: Concatenates two position lists or a position with a position list to a new PositionList containing all positions in the given order. Note that this operation is associative, that means it does not matter if you use braces in multiple concatenations or not.

Syntax Samples:

```
newpolist = po(po(2,3), po(5,7)) .. po(4, 4) -- = (2,3),(5,7),(4,4)
```

Caveats: Note that due to the value nature of position lists the concatenation creates a new value. This is an expensive operation. When you are collecting potentially large number of positions in a loop, you should not concat each new candidate to an existing position list. Avoid the creation of numerous position list values and collect the positions in a standard Lua table. Convert this table at the end to a position list (See Section 5.10.4 [PositionList Conversion], page 105).

```
result = {}
for x = 1, 200 do
    table.insert(result, po(x, 17))
end
return po(result)
```

5.9.5 PositionList Translation

Syntax: result = *polist* <+|-> <*pos* | *obj* | *cpos*>

result = <*pos* | *obj* | *cpos*> <+|-> *polist*

Details: If a position or data convertible to a position is added to or subtracted from a position list a new list is created with the positions representing the sum or difference of the position with every member of the position list. In total the position list is shifted by the position as a vector.

Syntax Samples:

```
newpolist = po(2, 3) + NEIGHBORS_4      -- po(1, 3) .. po(2, 4) .. po(3, 3)
newpolist = po["myfloor#*"] - po(3, 0)
```

5.9.6 PositionList Stretching

Syntax: result = *polist* * *number*

result = *number* * *polist*

Details: A scalar multiplication or division of all positions in a position list. All position values are multiplicated or divided by the given number in both coordinate values. In total the position list is stretched by a scalar factor.

Syntax Samples:

```
newpolist = 2 * NEIGHBORS_4                -- = po(9, 12)
newpolist = (po(2,4) .. po(6,7)) * 1/2     -- = (1, 2), (3, 3.5)
```

5.10 Positions Repository

The Positions datatype is just used by a single instance, the singleton repository of named positions. Besides the management of named positions it provides useful conversions of other datatypes to position based types.

Being a singleton you can not create a new Positions Repository. The singleton that is available on level load is stored at the global variable ‘po’.

The position repository is an extension of the Section 5.8 [NamedObjects], page 101, repository. Whenever you name an object, See Section 4.2.3 [Object Naming], page 50, this repository registers its name and allows you to retrieve lateron the current object’s position by providing its name. But even when a floor object gets killed, its position entry remains stored as Section 4.4.5 [Named Positions], page 60. Of course you can name positions yourself, but positions of existing named objects will always override plane named positions on name clashes.

For task driven samples see Section 5.2.7 [Named Positions Tasks], page 77.

5.10.1 Positions Repository Request

Syntax: result = po["*name*"]

Details: Request of one or several positions from the repository. If no wildcard characters are used in the name the Section 5.5 [Position], page 89, value of the unique object with the given name, if existent, is returned. It no object exists with the name, the last position stored with the same name is returned. If no position exists the value 'nil' is returned.

If the requested name contains a wildcard character, either an asterisk '*' or a question mark '?', a Section 5.9 [PositionList], page 102, containing all positions with matching names is returned. An asterisk matches zero, one or several arbitrary characters. A question mark matches a single arbitrary character. Both wildcard characters can be used anywhere in the string and in arbitrary multiplicity. Anyway the result is always returned as a Section 5.9 [PositionList], page 102. The list may contain multiple positions, just a single position, or even no position at all when no existing position matches your name pattern.

Syntax Samples:

```
pos = po["mydoor"]         -- exact name match
polist = po["mydoors#*"]  -- any suffix
polist = po["mydoor?"]    -- just one char suffix
polist = po["mydoors?#*"] -- matches e.g. "mydoorsA#123435", "mydoorsB#1213"
```

5.10.2 Positions Repository Storage

Syntax: po["*name*"] = *obj*

Details: Index write accesses to the singleton allows you to name or rename positions. Note that can not assign a new position to a name that currently references an existing Section 5.6 [Object], page 92. Such write access are silently ignored.

Syntax Samples:

```
po["mypos"] = pos
```

5.10.3 Position Conversion

Syntax: result = po(<*obj* | *pos* | {x, *y*} | x, *y* >)

Details: Converts its argument to a new position value.

Syntax Samples:

```
pos = po(pos2)
pos = po(obj)
pos = po({2, 4})
pos = po(3, 7)
```

5.10.4 PositionList Conversion

Syntax: result = po(*group* | {*pos1*, *pos2*, *pos3*})

Details: Converts the given group or table of positions to a new Section 5.9 [PositionList], page 102, value, that contains the positions of all valid group Section 5.6 [Object], page 92s or table members in the same sequence.

Syntax Samples:

```
polist = po(group)
polist = po({po(3, 7), po(2, 6)})
polist = po({})  -- an empty position list
```

5.11 Tile and Object Declaration

A tile is the description of one or several objects that should be positioned on the same grid position. A single object can be set up by a straight object declaration, an anonymous Lua table with entries for the object kind and all attributes. The object declaration comes in three minor variations:

```
{"st_chess", name="jumper", color=WHITE}
{"st_chess_white", "jumper", _myattr=5}
{"ac_marble", 0.2, 0.6, name="blacky"}
```

The first entry, the one stored at table position '1', has always to be the kind name of a supported Enigma object. In the first example all other table entries are key value pairs with the key being the attribute name. The second example uses the shortcut of specifying the name attribute value as second table entry, that will be stored at table position '2'. It has to be a string value. The third variation, that is useful for actor declarations, stores the grid offsets in x and y directions in the table positions '2' and '3'. Of course you can not use the name attribute shortcut in the same declaration.

These table driven object declarations are always sufficient if you just want to set a single object at once. But tiles do often take an item or a stone besides a floor. So we need an Enigma data type being able to handle these multiple declarations. This is the '`tile`' data type. It can take just one object declaration or an arbitrary list of declarations. You convert a table object declaration into a tile by the Section 5.12 [Tiles Repository], page 107, handle. Once you have a tile you can concat other tiles or table object declarations to set up new tiles.

Enigma guarantees that the objects will be set to the world in the sequence of declarations in the tile.

Even though in most cases you use object declarations and tiles to set objects you may need in some advanced usage cases to supply such a datatype in situations where you want to add nothing at all or even want to kill a possibly existing object. In these cases you can supply one of the pseudo object kind names `"fl_nil"`, `"it_nil"`, `"st_nil"` or `"nil"`. While the first three pseudo kinds will kill existing objects on the given layer, the last pseudo kind will just do nothing. It is equivalent, but more expressive than an empty Lua table being used as an object declaration:

```
ti["D"] = cond(wo["IsDifficult"], {"st_death"}, {"nil"})
ti["S"] = {"st_surprise", selection={"st_box", "st_nil"}}
function customresolver(key, x, y)
    if key == "a" then
        return {"nil"}
    elseif key == "b" then
        return {}
    else
        return ti[key]
```

```
          end
      end
```

The first sample uses the pseudo to supply a valid third arguement to the Section 5.14.3 [cond], page 120, function that causes no syntax error when being passed to the world in easy mode.

The second sample uses the pseudo to kill the Section 9.5.62 [st_surprise], page 305, even when no substitution stone is being set.

The last example of a Section 13.1.2 [Custom Resolver], page 373, provides a solution for avoiding the change of the world on a given key in the world map. Usually you will always set at least a floor object. But if you draw a map during runtime there is no longer the need of setting inital floors. In cases where this can not be handled by proper usage of default keys the pseudo kind `"nil"` is your friend.

For task driven samples see Section 5.2.6 [Tiles and World Tasks], page 77.

5.11.1 Tile concat

Syntax: result = *tile* .. <*tile* | *odecl*>

result = <*tile* | *odecl*> .. *tile*

Details: Compose a new tile by concatenation of a tile with another tile or a table object declaration. In a concatenated chain of tiles and object declarations one of the first two evaluated arguments needs to be a tile as two Lua tables do not know how to concat.

Note that Lua does evaluate the '`..`' operator from right to left! Thus you need either use proper braces or you need to guarantee that at least one of the two rightmost tokens is a tile.

Syntax Samples:

```
newtile = ti{"st_chess"} .. {"fl_sahara"}
newtile = ti{"st_chess"} .. {"fl_sahara"} .. {"it_cherry"}   -- Lua error due to
newtile = (ti{"st_chess"} .. {"fl_sahara"}) .. {"it_cherry"} -- evaluation order
newtile = ti{"st_chess"} .. {"fl_sahara"} .. ti{"it_cherry"} -- converted one of
```

5.12 Tiles Repository

The Tiles datatype is just used by a single instance, the singleton repository of Section 5.11 [Tile and Object Declaration], page 106s. Besides the management of tiles it provides useful conversions of table based object declarations to tiles.

Being a singleton you can not create a new Tiles repository. The singleton is stored at the global variable '`ti`' on level load.

The repository stores tiles for given string keys. The key strings can be of any length. Due to Lua limitations they need to be composed of printable 7-bit ASCII characters.

You can assign a tile to every key just once. A reassign causes an error. On one hand this allows internal implementation optimization, but on the other hand an unforeseen key reassignment is the most common level coding error that needs to be reported.

For task driven samples see Section 5.2.6 [Tiles and World Tasks], page 77.

5.12.1 Tiles Storage

Syntax: ti["*key*"] = <*tile* | *odecl*>

Details: Index write accesses to the singleton allows you to assign a tile or an table based object declaration, that is autoconverted to a tile, to a given key. The key must be a unique string. Unique in the sense that you can not reassign a new tile to key to which previously another tile has been assigned.

Syntax Samples:

```
ti["#"] = tile
ti["$"] = {"st_chess"}
ti["$"] = {"st_switch"}   -- error of key reassignment
ti["anykey"] = {"st_chess"}
```

5.12.2 Tiles Request

Syntax: result = ti["*key*"]

Details: Request of the tile that has been assigned to the given key. If no tile has yet been stored for the key a Lua 'nil' value is returned. Note that this tiles repository does not use wildcard characters as the named objects and positions repositories do. The asterisk '*' and question mark '?' are just keys as any other characters.

Syntax Samples:

```
tile = ti["#"]
```

5.12.3 Tile Conversion

Syntax: result = ti(*odecl*)

Details: Converts a table based object declaration to a new tile value.

Syntax Samples:

```
tile = ti({"st_chess"})
tile = ti{"st_chess"}   -- Lua syntax equivalence
```

5.13 World

The World datatype is just used by a single instance, another singleton object. A reference to this singleton is stored at the Lua global variable 'wo' on level load. Being a singleton you can not instantiate another World object.

But even though the singleton 'wo' already exists on load of a level the world is still undefined in all aspects. From the first line of Lua code you can access the Section 6.4 [Global Attributes], page 137. But the world gets really set up with the Section 5.13.1 [World Creation], page 108. After this call the world has a well defined size and is filled with an initial set of objects that you can access and modify from this moment on.

5.13.1 World Creation

Once all parameters have been set and all tiles have been declared it is time to create the level world with all its objects. This is done by the following constructor that appears in three variations.

Syntax: width, height = **wo**(*topresolver*, *defaultkey*, *map*)

width, height = **wo**(*topresolver*, *libmap*)

width, height = **wo**(*topresolver*, *defaultkey*, *width*, *height*)

topresolver = `ti` | *resolver* | *localresolver*
: Every tile in the world is given by a key that needs to be resolved to its declaration. This can be done either by the Section 5.12 [Tiles Repository], page 107, '`ti`', or by given library Section 13.1 [Resolvers], page 372, or by a local Section 13.1.2 [Custom Resolver], page 373, function. This argument takes the top resolver that is requested first.

defaultkey
: A string that defines the key that should be taken as default. It is taken if no other key is given and it is added to a tile if a floor object is missing. The character length of this key defines the key size within the map

map
: A table of strings. Each string describes a row of tiles by its tile keys. If a map is given, the world size is determined from the longest string and the number of rows.

libmap
: A map of the library Section 12.4 [libmap], page 344,

width
: As an argument that is given instead of a map it describes the width of the desired world.

height
: As an argument that is given instead of a map it describes the height of the desired world.

Syntax Samples:

```
w, h = wo(ti, "  ", 20, 13)
w, h = wo(resolver, " ", {
       "                    ",
       ...
       "                    "})
w, h = wo(ti, mylibmap)
```

Details: This world constructor may just be called once. Every subsequent call causes an error. This call sets the size of the world to fixed values that are reported by its two return values. The world size can later on be retrieved by the world attributes Section 6.4.35 [Width], page 146, and Section 6.4.18 [Height], page 142, too.

A mapless world is filled with default tiles. Rows in a given map that are shorter than others are filled with default tiles, too. Any tile that does not define a floor object will add the floor object of the default tile.

Every key is resolved to its tile declaration via the given resolver chain. The top resolver is given to this call as a parameter. If it is '`ti`' the chain consists just of one element and the tile declaration stored in the tiles repository at the given key is taken. Otherwise the resolvers will be evaluated as explained in Section 13.1.1 [Resolver Chaining], page 372.

5.13.2 World Tile Set

Syntax: **wo**[<*object* | *position* | *table* | *group* | *polist*>] = *tile_declarations*

Details: Index write accesses to an index that can be interpreted as a grid position or a list of grid positions allows you to set one or several new objects to the given positions according to the supplied tile declaration.

Syntax Samples:

```
wo[no["myobjectname"]] = {"st_chess"}
wo[po(3, 4)] = ti["x"]
wo[{2, 5}] = ti["x"] .. ti["y"]
wo[no["floorgroup#*"]] = {"it_burnable_oil"}
wo[no["myobjectname"] + NEIGHBORS_4] = ti["x"]
```

5.13.3 Global Attribute Set

Syntax: **wo**["attritbutename"] = value

Details: Write accesses to string type indices allows you to change Section 6.4 [Global Attributes], page 137. Just existing attributes with write accessibility may be changed. Note that some attributes must be set prior Section 5.13.1 [World Creation], page 108, to take proper affect.

Syntax Samples:

```
wo["ConserveLevel"] = true
```

5.13.4 Global Attribute Get

Syntax: *var* = **wo**["attritbutename"]

Details: Read accesses to string type indices allows you to retrieve Section 6.4 [Global Attributes], page 137. Just existing attributes with read accessibility can be read. Note that some attributes report proper values just after Section 5.13.1 [World Creation], page 108.

Syntax Samples:

```
var = wo["IsDifficult"]
```

5.13.5 add

Add Chapter 11 [Other Objects], page 330, to the world or a portable item to an inventory or other container object.

Syntax: **wo:add**(*tile_declarations*)

wo:add(*target*, *tile_declarations*)

tile_declarations
: One or many other object declarations given as tiles or anonymous tables.

target
: 'YIN', 'YANG' or valid Section 4.2.2 [Object Reference], page 49,

Syntax Samples:

```
wo:add({"ot_rubberband", anchor1="a1", anchor2="w", length=2, strength=80, t
wo:add(ti["r"] .. {"ot_wire", anchor1="w1", anchor2="w2"})
wo:add(YIN, {"it_magicwand"})
wo:add(no["mybag"], {"it_magicwand"} .. ti["h"] .. ti["c"])
```

Details: Just Chapter 11 [Other Objects], page 330, can be directly added to the world. Just portable Chapter 8 [Item Objects], page 182, can be added to the player's inventories '`YIN`' and '`YANG`' and to Section 8.3.1 [it_bag], page 184s. No other targets do currently add objects by this method.

5.13.6 drawBorder

Draw a border around a rectangle out of given tiles.

Syntax: **wo:drawBorder**(*upperleft_edge*, *lowerright_edge*, <*tile* | *key*, *resolver*>)

wo:drawBorder(*upperleft_edge*, *width*, *height*, <*tile* | *key*, *resolver*>)

upperleft_edge	Upper left anchor position of the rectangle.
lowerright_edge	Lower right end position of the rectangle.
width	Width of the rectangle.
height	Height of the rectangle.
tile	A tile or an object declaration.
key	A key string to be resolved via the given resolver.
resolver	A resolver to be used for resolving the key to a valid tile.

Syntax Samples:

```
wo:drawBorder(po(0, 0), wo["Width"], wo["Height"], ti["#"])
wo:drawBorder(no["myRectUL"], no["myRectLR"], {"st_grate1"})
wo:drawBorder(no["myRectUL"], no["myRectLR"], {"fl_water"} .. ti["X"])
wo:drawBorder(no["myRectUL"], no["myRectLR"], "x", myresolver)
```

Details: The rectangle as four one grid thick lines is drawn with the given tile. That means on every position of the rectangle itself an instance of every object of the tile declaration is set. The rectangle may degenerate to a single line.

5.13.7 drawMap

Even if the world is initialized by a map on creation of the world (see Section 5.13.1 [World Creation], page 108), it is sometime useful to be able to draw smaller submaps either as part of the initialization or as dynamic level changes within Section 4.3.3 [Callback Function], page 56. Of course the main purpose of '`drawMap`' is the drawing of repeating patterns.

Syntax:

wo:drawMap(*resolver*, *anchor*, *ignore*, *map*, [*readdir*])

wo:drawMap(*resolver*, *anchor*, *libmap-map*, [*readdir*])

subresolver

Resolver to which unresolved requests should be forwarded. May be '`ti`' as the final resolver of the resolver chain.

anchor The anchor position where the upper left tile of the map should be drawn.

ignore A tile key string that should be ignored. This key string is mandatory, even if it not used within the map.

map A table of strings. Each string describes a row of tiles by its tile keys.

libmap-map
If the map used is created via Section 12.4 [libmap], page 344, the '`ignore`'-string can be omitted. The map's default key will then be ignored instead.

readdir An optional argument to modify the direction of the map relative to the world. This argument can be any of the constants described in Section 12.4.3 [Rotating and Mirroring Maps], page 345.

Syntax Samples:

```
wo:drawMap(ti, po(5, 7), "-", {"abcabc"})
wo:drawMap(ti, anchor_object, "--", {"--##--##","##--##"})
wo:drawMap(ti, {12, 5}, " ", {"122  221"}, MAP_ROT_CW)
```

Details: The syntax is similar to the world creation call. But there are two essential differences you need to be aware of. First the map is drawn in the already existing world. Thus we need to define the position. This is done via the anchor position, which can be an already existing object, too.

The second difference is in the definition of a tile key string for tiles in the map that should be ignored. Remember that the world initialization requested a default tile key string. This default is still valid. But with the given ignore key string we can draw arbitrary shaped patterns by filling unused grids in the map with this key.

The length of the ignore key defines the map key length. It is strongly recommended to use the same key length as in the world map.

The rows of the supplied map are drawn from the anchor position. The rows may be of different length and may start with ignore tile keys. The anchor must be the position composed of the smallest x and smallest y coordinate within the pattern.

You can use drawMap anywhere after the world creation. You are even allowed to use it within the world creation in a resolver.

Full Example:

```
ti[" "] = {"fl_plank"}
ti["X"] = {"st_oxyd"}
ti["B"] = {"st_passage_black", flavor="frame"}
ti["W"] = {"st_passage_white", flavor="frame"}
ti["y"] = {"it_yinyang"}
ti["1"] = {"#ac_marble_black"}
ti["2"] = {"#ac_marble_white"}

```

```
function myresolver(key, x, y)
    if key == "w" then
        wo:drawMap(ti, po(x-1, y-1), "-", {"-W-",
                                           "WXW",
                                           "-W-"})
        return ti({})
    elseif key == "b" then
        wo:drawMap(ti, po(x-1, y-1), "-", {"-B",
                                           "BXB",
                                           "-B"})
        return ti({})
    else
        return ti[key]
    end
end

w, h = wo(myresolver, " ", {
  "                    ",
  "  b         b       ",
  "       w       w    ",
  "                    ",
  "                    ",
  "   w                ",
  "         12      b  ",
  "              w     ",
  "         w          ",
  "      b             ",
  "   w           b    ",
  "         b          ",
  "                    "
})
wo:shuffleOxyd()
```

5.13.8 drawRect

Fill a rectangle with a given tile.

Syntax: **wo:drawRect**(*upperleft_edge*, *lowerright_edge*, <*tile* | *key*, *resolver*>)

wo:drawRect(*upperleft_edge*, *width*, *height*, <*tile* | *key*, *resolver*>)

upperleft_edge
: Upper left anchor position of the rectangle.

lowerright_edge
: Lower right end position of the rectangle.

width Width of the rectangle.

height Height of the rectangle.

tile A tile or an object declaration.

key A key string to be resolved via the given resolver.

resolver A resolver to be used for resolving the key to a valid tile.

Syntax Samples:

```
wo:drawRect(po(0, 0), wo["Width"], wo["Height"], ti[" "])
wo:drawRect(no["myRectUL"], no["myRectLR"], {"fl_water"})
wo:drawRect(no["myRectUL"], no["myRectLR"], {"fl_water"} .. ti["#"])
wo:drawRect(no["myRectUL"], no["myRectLR"], "x", myresolver)
```

Details: The complete rectangle is filled with the given tile. That means on every position of the rectangle and its interior an instance of every object of the tile declaration is set. The rectangle may degenerate to a single line.

5.13.9 world floor

Retrieves the floor objects for the given position or positions.

Syntax: result = **wo**:**fl**(<*pos* | {*x*, *y*} | *x*, *y* | *obj* | *group* | *polist*>)

Details: This world method is identical to the global function Section 5.14.5 [fl], page 121.

5.13.10 world item

Retrieves the item objects for the given position or positions.

Syntax: result = **wo**:**it**(<*pos* | {*x*, *y*} | *x*, *y* | *obj* | *group* | *polist*>)

Details: This world method is identical to the global function Section 5.14.7 [it], page 122.

5.13.11 shuffleOxyd

Shuffling the color distribution of the Section 9.5.44 [st_oxyd], page 284, makes every level, that is no meditation, a bit generic. On every level start the level looks a little bit different and the user has to solve a modified level. This provides long term amusement. Thus the call of this method is part of most levels.

Many levels just call this method without any arguments. This results in a shuffling of all Section 9.5.44 [st_oxyd], page 284, that are not excluded by a '`noshuffle`' attribute.

But sometimes levels need to influence the shuffling, either for ensuring that the level remains solvable, or simply to ensure fairness. Imagine a level that has two Section 9.5.44 [st_oxyd], page 284s in every corner. If by chance a user gets a distribution where he has in each corner a pair of same colored oxyds, the level might be trivial. Another level may have a passage that the marble can pass just a few times. With 5 or more oxyds on each side of the passage you need to ensure that the marble never needs to pass the passage more often than possible. Both situations can be handled by providing proper rules as arguments to this method.

Syntax:

wo:shuffleOxyd(*rules*)

rules = *rule*, *rule*,...
No rule or as many as you like, all separated by a comma.

rule = {*group1*, *group2*, *maxrule*, *minrule*, *circularrule*, *linearrule*, *log*}
: Each rule is a table with a subset of the listed entries. The *group1* entry is mandatory. All other entries are optional and can be added in any combination.

group1 = *group* | *objectreference* | *objectspecifier*
: A description of oxyd objects that are part of the first rule group. Either a group or a single object reference or a string specifier that resolves to a single or via wildcard to several oxyd objects are legal descriptors.

group2 = *group* | *objectreference* | *objectspecifier*
: A description of oxyd objects that are part of the second rule group. Either a group or a single object reference or a string specifier that resolves to a single or via wildcard to several oxyd objects are legal descriptors.

maxrule = `max = ` *number*
: The maximum number of oxyd pairs.

minrule = `min = ` *number*
: The minimum number of oxyd pairs.

circularrule = `circular = true`
: Avoid any pair of neighboring oxyds in group1. Avoid an oxyd pair of first and last oxyd in group1, too.

linearrule = `linear = true`
: Avoid any pair of neighboring oxyds in group1.

log = `log =  "solution" |"count" |"all"`
: Log additional information to the log stream for debugging purposes and security checks by the level author.

Syntax Samples:

```
wo:shuffleOxyd()
wo:shuffleOxyd({no["borderoxyds#*"]:sort("circular"), circular=true})
wo:shuffleOxyd({"leftoxyds#*","rightoxyds#*", min=3}, {"islandoxyds#*", max=
```

Details:

Any call of '`wo:shuffleOxyd()`' must occur after all Section 9.5.44 [st_oxyd], page 284, have been set. That means that it must follow the standard world initialization (see Section 5.13.1 [World Creation], page 108). As a side effect shuffleOxyd will assign colors to all '`OXYD_AUTO`' colored Section 9.5.44 [st_oxyd], page 284.

Once called the given shuffling rules remain valid. Any further reshuffling must be done by messages '`closeall`' and '`shuffle`' to one arbitrary Section 9.5.44 [st_oxyd], page 284, instance. No addition of an Section 9.5.44 [st_oxyd], page 284, or subsequent '`wo:shuffleOxyd()`' calls are possible without disturbing and deleting the given rules.

Rule based shuffling is limited to a maximum of one pair of each standard oxyd color plus any combination of additional special fake, quake or bold oxyds summing up to a maximum of 32 oxyds. If more than 32 oxyds or 2 or more pairs of a single standard color are set, all oxyds will be shuffled by random ignoring any provided rules.

There are basically two different types of rules. Those with one group and those with two groups of oxyds (Note that group is the general API expression for a set of oxyds and not a mathematical group). For a single group the rules apply to the oxyd instances within this group. For two groups the rules apply to oxyd pairs with one oxyd in the first group and the other in the second group.

E.g. ‘`{"islandoxyds#*", max=0}`’ requests that there is no pair within this group of oxyds. Whereas ‘`{"leftoxyds#*","rightoxyds#*", min=3}`’ requests that there are 3 different oxyd pairs, each with one oxyd out of the leftoxyd group and the second out of the rightoxyd group.

Linear and circular rules can only be applied to a single group. They are shortcuts for the most common rules that are applied to oxyds arranged on a line or a circle. In both cases they avoid pairs of neighboring oxyds. They are equivalent to ‘`n-1`’ res. ‘`n`’ rules with all possible neighboring oxyd pairs as two groups and a rule of ‘`max=0`’.

Note that you can apply several rules at once to given groups. E.g. you can apply a minrule and a maxrule within one rule!

The shuffling process consists always of two stages. The most important first stage generates a valid oxyd pair distribution. That means that we settle which pairs will have the same color. But the color itself is assigned in an independent second stage. As for the examination of given rules just the pair distribution is relevant, we do just count and log these different distributions ignoring the colors.

With 16 oxyds of 8 different colors and no restricting rules you have 2027025 (15 * 13 * 11 * 9 * 7 * 5 * 3) different valid distributions. Keep in mind that useful rules should always keep hundreds or thousands of different valid distributions for a level.

For debugging purposes you can add a log parameter to one of the rules (it does not matter to which one). If you request the log of ‘`solution`’ the pair distribution will be printed to the log stream.

In case of ‘`count`’ the number of different oxyd distributions will be counted and logged. It is recommended to check the count on complex rules to ensure that enough distributions remain for a varying game. But be careful applying count on trivial rules. With 16 oxyds there may be as many as 2027025 distributions and it may take a standard PC up to 30 seconds to count them - add a factor of 17*19 for 20 oxyds!

Be very, very cautious in usage of logging ‘`all`’. This call tries to print all solutions. It takes ages if there are too many solutions. First check the count before trying to log the solutions.

Full Example:

```
wo["ConserveLevel"] = false

ti["~"] = {"fl_water"}
```

```
ti[" "] = {"fl_plank"}
ti["c"] = {"it_crack_l", brittleness=0}
ti["^"] = {"st_oneway_n"}
ti["1"] = {"ac_marble_black", 0, 0.5}

ti["x"] = {"st_oxyd", "island#"}
ti["y"] = {"st_oxyd", "left#"}
ti["z"] = {"st_oxyd", "right#"}

w, h = wo(ti, " ", {
  "~~x  x  x  x  x  x~~",
  "~~                ~~",
  "~~~~~~~~~~~~~~~~~~~~",
  "y       ~~~~       z",
  "~       cccc       ~",
  "y       ~~~~       z",
  "~       cccc       ~",
  "y       ~~~~       z",
  "~       cccc       ~",
  "y       ~~~~       z",
  "~~~~c~~~~~~~~~~c~~~~",
  "~~                ~~",
  "~~        1       ~~"
})

wo:shuffleOxyd({"island#*", min=3, linear=true}, {"left#*","right#*", max=
```

This level uses 14 oxyds. The 6 oxyds in the upper row are on an island that can not be left once the marble entered it through one of the oneways. Thus we need 3 pairs of oxyds on this island, which are enforced by the min rule. To avoid trivial neighboring pairs on the island, we do add a linear rule, too. The marble can pass just three times between the left and right islands. This allows a first look on the color oxyds with one pass and opening one pair on each of the two following passes. Thus we limit the number of pairs by a max rule to 2. To avoid trivial oxyd pair distributions, like two pairs on the left and two pairs on the right side, we do add a min rule that enforces that two shared pairs of oxyds do exist.

5.13.12 world stone

Retrieves the stone objects for the given position or positions.

Syntax: result = **wo**:**st**(<*pos* | {*x*, *y*} | *x*, *y* | *obj* | *group* | *polist*>)

Details: This world method is identical to the global function Section 5.14.10 [st], page 124.

5.14 Functions

Besides all the features strongly related to a value as context and thus implemented as operators or methods of these datatypes, a few other tasks remain. These are either context free or take at least in one variation just a standard Lua datatype, that does not supply a context. Thus these tasks are implemented as simple functions.

5.14.1 assert_bool

The function '`assert_bool`' throws an error if a given condition doesn't hold.

Syntax: **assert_bool**(*condition*, *message*, *level*)

condition A boolean expression or anything else. If it is `false` or `nil`, an error will be thrown.

message A string, holding the error message. If `message` is nil or empty, an "anonymous assertion" will be thrown, but it's always better to provide a meaningful error message.

level `level` specifies the error position in the same way as does Lua's '`error`'-function. Default is 1.

Syntax Samples:

```
assert_bool(no["mystone"]:exists(), "Stone 'mystone' has disappeared.")
```

Details: Assertions help you to detect coding errors. They are heavily used on argument checks of library functions and resolver implementations. As the assertions should not lead to performance penalties during runtime they are usually just evaluated when the level's '`status`' is declared in the XML header element Section 3.3.2 [<version>], page 30, with a value of either `"test"` or `"experimental"`.

For `"stable"` and `"released"` levels standard assert statements are simply skipped on compilation like Lua comments. But you can enforce assert statements to be executed even in these modes by the following pattern of assignment and additional braces:

```
dummy = (assert_bool)(no["mystone"]:exists(), "Stone 'mystone' has disappeare
```

Similar to Section 5.14.3 [cond], page 120, all side effects within the evaluation of '`message`' and '`level`' will appear.

See Lua's manual for more detailed information about the '`error`'-function.

5.14.2 assert_type

The function '`assert_type`' throws an error if the first argument is not of one of the specified types.

Syntax: **assert_type**(*var*, *vardescription*, *level*, *type1*, *type2*, ...)

var Any kind of variable.

vardescription

If '`var`' is not of one of the types '`type1`', '`type2`' ..., then an error message will be thrown which includes the actual type of '`var`' and the desired types. '`vardescription`' is a string which holds additional information for the error message. It should be a lower-case not-too-short description of '`var`' (a name, as it is), additional details should be added in brackets.

level `level` specifies the error position in the same way as does Lua's '`error`'-function. Can't be omitted, use '`1`' if in doubt.

type1, *type2*, ...
A sequence of strings. If '`var`' is none of these types, the error will be thrown. See details below for type descriptors.

Syntax Samples:

```
assert_type(arg1, "mygreatfunction first argument (level width)", 1, "nil", "
itive integer", "position")
```

Details: Assertions help you to detect coding errors. They are heavily used on argument checks of library functions and resolver implementations. As the assertions should not lead to performance penalties during runtime they are usually just evaluated when the level's '`status`' is declared in the XML header element Section 3.3.2 [<version>], page 30, with a value of either `"test"` or `"experimental"`.

For `"stable"` and `"released"` levels standard assert statements are simply skipped on compilation like Lua comments. But you can enforce assert statements to be executed even in these modes by the following pattern of assignment and additional braces:

```
dummy = (assert_type)(arg1, "myfunction first argument", 1, "integer")
```

Possible types are all Lua types (like `"nil"`, `"number"`, `"boolean"`, `"string"`, `"table"`, `"function"`) except `"userdata"`, all Enigma-own user types (`"object"`, `"position"`, `"tile"`, `"tiles"`, `"group"`, `"world"`, `"polist"`, `"unknown"`), and types defined inside metatables (`"map"` from Section 12.4 [libmap], page 344), see Section 5.14.4 [etype], page 121. In addition, the following type descriptors are recognized:

`"integer"`
Any integer number (..., -2, -1, 0, 1, 2, ...)

`"positive"`
Any number which is positive and not zero.

`"non-negative"`
Any number which is not negative, i.e. which is positive or zero.

`"natural"`
Any non-negative integer number (0, 1, 2, ...).

`"positive integer"`
Any positive integer number (1, 2, 3, ...).

`"non-empty string"`
Any string other than the empty string `""`.

`"any table"`
: If '`var`' is a table, the '`_type`'-attribute of its metatable will be used as its Section 5.14.4 [etype], page 121. In particular, it won't be accepted as a `"table"` anymore, if this '`_type`'-attribute exists. For example,

```
assert_type(mytable, "large table", 1, "table")
```

will throw an assertion when '`mytable`' is a `"map"`, although, technically, a `"map"` always is a `"table"`. You can use `"any table"` as type to allow for any table, regardless of its metatable.

`"valid object"`
: Any valid object.

Similar to Section 5.14.3 [cond], page 120, all side effects within the evaluation of '`vardescription`', '`level`' and any type descriptor will apply.

See Lua's manual for more detailed information about the '`error`'-function.

Full Example:

```
function paint_lawn(pos)
    assert_type(pos, "paint_lawn first argument", 2, "position", "object", "
    if etype(pos) == "object" then
        assert_bool(-pos, "paint_lawn: Object not existing.", 2)▌
    end
    wo[pos] = ti["lawn"]
end
paint_lawn(no["mystone"])
paint_lawn("myotherstone")
```

If '`mystone`' doesn't exist, `no["mystone"]` will still be of etype `"object"`, an invalid object. Hence `assert_type` will not trigger, but `assert_bool` will.

If '`mystone`' exists, the second '`paint_lawn`' will throw an error via '`assert_type`', as `pos` now is a `"string"`. The error message will be:

```
Wrong type for paint_lawn first argument, is string, must be one of position
object, polist, group, table.
```

5.14.3 cond

'`cond`' is a conditional assignment, a substitution for the ternary '`?:`' operator of C-like languages. Note however, that it is not an equivalent substitution but just a workaround with some subtle side effects.

Syntax: **cond**(*condition*, *iftrue*, *iffalse*)

condition	A boolean expression.
iftrue	The expression to be returned if '`condition`' is true.
iffalse	The expression to be returned if '`condition`' is false.

Syntax Samples:

```
ti["x"] = cond(wo["IsDifficult"], {"st_death"}, ti["#"])
ti["D"] = cond(wo["IsDifficult"], {"st_death"}, {"nil"})
```

Details: ‘cond’ always evaluates both expressions ‘iftrue’ and ‘iffalse’, regardless of ‘condition’. Hence,

```
mytable = {1,2,3,4,5,6,7,8,9,0}
removed_element = cond(i < 5, table.remove(mytable, i), table.remove(mytable
```

will always remove two elements. With ‘i=2’ the ‘2’ will be returned but ‘mytable’ will result in ‘{1,3,4,5,7,8,9,0}’, and with ‘i=6’ you get the ‘5’ but mytable will be ‘{1,2,3,4,7,8,9,0}’.

Another Enigma example that will cause errors is:

```
w,h = cond(wo["IsDifficult"], wo(ti, " ", map1), wo(ti, " ", map2))
```

Both, the second and the third argument will be evaluated. Thus two contradicting attempts to create a new world will be made causing the second one to fail. Use the following statement instead:

```
w,h = wo(ti, " ", cond(wo["IsDifficult"], map1, map2))
```

However, in most cases ‘cond’ is used anyway with static expressions for ‘iftrue’ and ‘iffalse’ (e.g. strings or variables) and no side effects will occur.

5.14.4 etype

The function ‘etype()’ returns the advanced type of its argument.

Syntax: **etype**(*var*)

var Any kind of variable.

Syntax Samples:

```
argtype = etype(value)
```

Details: Lua types are "nil", "number", "boolean", "string", "table", "function", "userdata", and "thread". You can use Lua’s ‘type’-function to query the type of any variable. However, Enigma defines more types through various means, and these types can be queried via ‘etype’. ‘etype’ will return its argument’s Lua type as usual, with the following two exceptions:

"*userdata*"

Instead of "userdata", Enigma’s special types will be returned. These special types are "object", "position", "tile", "tiles", "group", "world", "polist" and "default". If an unknown userdata is encountered, "unknown" will be returned.

"*table*" If var is a table, its metatable will be queried. If there is an entry ‘_type’, this entry will be used as etype. Most important examples of this kind are Section 12.4 [libmap], page 344-maps, Section 13.1 [Resolvers], page 372, and Section 13.1.5 [res.maze], page 379, with its mazes and cells. So ‘etype’ will return "map", "resolver", "maze" and "cell", too. You may access the etype-system through ‘_type’ whenever you use metatables on your own.

5.14.5 fl

The function ‘fl()’ retrieves the floor objects for the given position or positions.

Syntax: result = **fl**(<*pos* | {*x*, *y*} | *x*, *y* | *obj* | *group* | *polist*>)

Details: If the argument describes a single position, the floor object at this position is returned. When this single position is outside of the world an invalid '`NULL`' Section 5.6 [Object], page 92, reference is returned.

If the argument is either a Section 5.7 [Group], page 96, or Section 5.9 [PositionList], page 102, all floor objects of the related positions are retrieved and added in the same sequence to a new result group. Invalid positions will be skipped without adding an object to the group.

In any case you can send messages to the result value.

Syntax Samples:

```
floor = fl(po(3, 5))
floor = fl({3, 5})
floor = fl(3, 5)
floor = fl{3, 5}     -- by Lua syntax equivalence
floor = fl(mystone)
group = fl(no["door#*"])
group = fl(po(3, 5)..po(4, 2))
```

5.14.6 grp

The function '`grp()`' builds a Section 5.7 [Group], page 96, out of its argument Section 5.6 [Object], page 92s.

Syntax: **grp**(<{*obj1*,*obj2*,...}| *obj1*,*obj2*,... |*group*>)

Details: Returns a new Section 5.7 [Group], page 96, that is build up by the objects listed by the arguments. The contents objects must be either listed in a Lua table, given as multiple single object arguments or an existing group. In all cases the sequence of objects is maintained in the returned new group, but all invalid '`NULL`' objects are omitted. In case one object is listed multiple times just the first instance will occur in the group and subsequent instances will be omitted.

Syntax Samples:

```
newgroup = grp(obj1, obj2, obj3)
newgroup = grp({obj1,obj2})
newgroup = grp{obj1,obj2}   -- Lua syntax equivalence
newgroup = grp{}            -- empty group
newgroup = grp(group)       -- a copy of group cleaned of in-
valid 'NULL' objects
```

5.14.7 it

The function '`it()`' retrieves the item objects for the given position or positions.

Syntax: result = **it**(<*pos*| {*x*, *y*}|*x*, *y*| *obj* | *group*| *polist*>)

Details: If the argument describes a single position, the item object at this position is returned. When no item is located at the given single position or this position is outside of the world an invalid '`NULL`' Section 5.6 [Object], page 92, reference is returned.

If the argument is either a Section 5.7 [Group], page 96, or Section 5.9 [PositionList], page 102, all item objects of the related positions are retrieved and added in the same sequence to a new result group. Invalid positions or positions without items will be skipped without adding an object to the group.

In any case you can send messages to the result value.

Syntax Samples:

```
item = it(po(3, 5))
item = it({3, 5})
item = it(3, 5)
item = it{3, 5}     -- by Lua syntax equivalence
item = it(mystone)
group = it(no["door#*"])
group = it(po(3, 5)..po(4, 2))
```

5.14.8 ORI2DIR

The table '`ORI2DIR[]`' converts orientation values to direction values.

Syntax: result = **ORI2DIR**[*orientation*]

Details: The table has stored the proper directions values at the index positions of the related orientations.

Syntax Samples:

```
direction = ORI2DIR[NORTH]      -- N  = po(0, -1)
direction = ORI2DIR[SOUTHEAST]  -- SE = po(1,  1)
direction = ORI2DIR[NODIR]      --      po(0,  0)
```

5.14.9 random

The function '`random()`' is a syntax compatible replacement for the standard Lua function '`math.random()`'. Both names refer to the same Enigma random implementation.

Syntax: result = **random**(<|*n*|*l*,*u*>)

Details: When called without arguments, math.random returns a pseudo-random real number in the range [0,1). When called with a number n, math.random returns a pseudo-random integer in the range [1,n]. When called with two arguments, l and u, math.random returns a pseudo-random integer in the range [l,u].

The only difference from the Lua implementation is the random generator itself. Enigma uses an own implementation that guarantees the same pseudo-random number sequence on any operating system and any processor for a given seed. This feature will be important for future Enigma versions and thus the randomseed can not be modified by the level itself.

Syntax Samples:

```
float = random()          -- e.g. 0.402834
integer = random(20)      -- e.g. 13
integer = random(5, 10)   -- e.g. 5
```

5.14.10 st

The function '`st()`' retrieves the stone objects for the given position or positions.

Syntax: result = **st**(<*pos* | {*x*, *y*} | *x*, *y* | *obj* | *group* | *polist*>)

Details: If the argument describes a single position, the stone object at this position is returned. When no stone is located at the given single position or this position is outside of the world an invalid '`NULL`' Section 5.6 [Object], page 92, reference is returned.

If the argument is either a Section 5.7 [Group], page 96, or Section 5.9 [PositionList], page 102, all stone objects of the related positions are retrieved and added in the same sequence to a new result group. Invalid positions or positions without stone will be skipped without adding an object to the group.

In any case you can send messages to the result value.

Syntax Samples:

```
stone = st(po(3, 5))
stone = st({3, 5})
stone = st(3, 5)
stone = st{3, 5}      -- by Lua syntax equivalence
stone = st(myfloor)
group = st(no["cherry#*"])
group = st(po(3, 5)..po(4, 2))
```

5.14.11 usertype

The function '`usertype()`' returns type info for Enigma data types.

Syntax: **usertype**(*var*)

var Any kind of variable.

Syntax Samples:

```
argtype = usertype(value)
```

Details: Just for Lua type `"userdata"` Enigma's special type info will be returned. These special types are `"object"`, `"position"`, `"tile"`, `"tiles"`, `"group"`, `"world"`, `"polist"` and `"default"`. If another data type is encountered, `"unknown"` will be returned.

The function Section 5.14.4 [etype], page 121, provides a more general type evaluation for arbitrary data types and is partially based on this function.

6 Common Attributes and Messages

Some attributes, messages and constants are common to many objects or even supported by all objects. We describe them here in detail. The following chapters will just reference them or even skip them when they are generally supported and used in the default manner.

6.1 Common Attributes

6.1.1 name

The attribute of Section 4.2.3 [Object Naming], page 50, that allows you to name any object for reference purposes. It is up to you to ensure the uniqueness of the names. But the engine supports you by autonumbering names ending on a '`#`' sign (see Section 4.2.3 [Object Naming], page 50). If you reuse an already used name the first object will be unnamed and all name references will point to the new named object. If you have need of naming an object you should do it with the object creation as a few objects have need of names and will otherwise be named by the engine with unique names.

Note that this attribute is not listed in the individual object descriptions.

Type: string
Values: {a-zA-Z0-9_}+
A sequence of characters of the given characters plus special characters as mentioned in the text above.

Default: `nil`
Some objects will be autonamed if no name is defined.

Access: read/write
Support: by all objects

6.1.2 state

The central attribute of any object that describes the current state of an object in its standard life cycle. This Section 4.3.4 [Object State], page 56, is described by a simple number. Most dynamic objects have just 2 states. Others may have more. The available states are listed with each object. This universal attribute allows common messages like Section 6.2.1 [toggle], page 129, Section 6.2.3 [signal], page 130, Section 6.2.4 [on], page 130, Section 6.2.5 [off], page 130, Section 6.2.6 [open], page 130, Section 6.2.7 [close], page 131.

Type: number
Values: dependent on the individual object
Please use the given upper case constants.

Default: `0`
Access: read/sometimes write
While it is common to set the state attribute on object creation, it is preferable to change the object state later on by messages.

Support: by all objects

6.1.3 target

All active objects react on being triggered by performing an action on their targets. This attribute is part of the Section 4.3.2 [Target - Action], page 54, paradigm that guarantees plugability of objects. You can either set a general '`target`' attribute for an object, or you can set Section 6.1.2 [state], page 125, dependent attributes '`target_0`', '`target_1`',... (see Section 4.3.4 [Object State], page 56). They all have the same syntax:

Type: string, object, group, tokens See Section 4.2 [Object Description], page 49
Single targets may be declared by their object name or their reference. Multiple targets can be declared by usage of groups and tokens.

Values: See Section 4.2.4 [Object Attributes], page 52

```
target = "myDoor"
target = myObject
target = {"myDoor", myObject}
target = {grp(obj1, obj2), "myDoor", myObject}
```

Default: `nil`
Access: read/write
Support: by all objects

6.1.4 action

All active objects react on being triggered by performing an action on their targets. This attribute is part of the Section 4.3.2 [Target - Action], page 54, paradigm that guarantees plugability of objects. You can either set a general '`action`' attribute for an object, or you can set Section 6.1.2 [state], page 125, dependent attributes '`action_0`', '`action_1`',... (see Section 4.3.4 [Object State], page 56). They all have the same syntax:

Type: string, tokens of strings See Section 4.3.2 [Target - Action], page 54
A single action may be declared by its message string. Multiple actions that match multiple targets can be declared by tokens of strings.

Values: See Section 4.2.4 [Object Attributes], page 52

```
action = "open"
action = {"open", "turn", "toggle"}
```

Default: `nil`
Access: read/write
Support: by all objects

6.1.5 nopaction

A very special addition to the Section 4.3.2 [Target - Action], page 54, paradigm that allows in case of state specific actions to deny the sending of default messages (see Section 4.3.4 [Object State], page 56).

Type: bool
Values: `true`, `false`
Default: `false`
Access: read/write
Support: by all objects

6.1.6 safeaction

A very special addition to the Section 4.3.2 [Target - Action], page 54, paradigm that allows to kill the sender within the execution of the action code.

Type: bool
Values: `true`, `false`
Default: `false`
Access: read/write
Support: by all objects

6.1.7 inverse

An attribute that requests an inversion of the action value. It is supported by all objects with boolean action values.

Note that this attribute is not listed in the individual object description if the object has boolean action values.

Type: bool
Values: `true`, `false`
Default: `false`
Access: read/write
Support: by most objects

All objects with boolean action values will support this attribute. Additionally some objects with other invertible action value types like orientations will support the inversion of their attributes as stated in the individual object descriptions.

6.1.8 destination

An attribute that describes one or several destinations. It is used by objects like Section 8.4.19 [it_vortex], page 227, and Section 8.4.20 [it_wormhole], page 229, to describe their teleporting destination and by Section 10.2.2 [ac_horse], page 322, to describe its traveling path.

Note that this attribute is only supported if it is listed in the individual description.

Type: tokens or a single position

Just a single position for a first destination is allowed. Use tokens to define multiple destination.

Values: See Section 4.2.4 [Object Attributes], page 52

```
destination = po(3.0, 4.7)
destination = "myFloor"
destination = myObject
destination = {"vortex2","vortex3","vortex4"}
po["dest1"] = po(3,4)
po["dest2"] = po(7,8)
destination = {"dest1","dest2","myFloor"}
```

Note that objects like ‘`it_wormhole`’ that have just a single destination do take the first token object. Note that in contrast to Section 6.1.3 [target], page 126, tokens a destination tokens argument can take named positions, too.

Referencing floors that may be destructed by bombs, cracks, floor building stones, etc. are safe destinations, too.

Default: `nil`
Access: read/write
Support: by teleporting objects

6.1.9 friction

An attribute that describes the decelerating friction force on actors that are on the floor. The friction force increases with the speed of the actor and is decelerating for positive friction values. But friction can be set to negative values as well what generates an accelerating force that is very difficult to control for the player.

Besides all floors some floor covering items like Section 8.4.16 [it_strip], page 224, Section 8.4.11 [it_meditation], page 219, may provide friction values as well to deviate from the floor friction.

Type: number
Values: any floating point number
Default: `nil`
Access: read/write
Support: by all floor, and floor covering item objects

6.1.10 adhesion

An attribute that describes the adhesion that allows an actor to accelerate on a floor. Greater adhesion leads to more accelerating force at the same given mouse speed. Adhesion can be set to negative values as well what generates an accelerating force in the inverse direction of the mouse movement which is a little bit difficult to control for the player.

Besides all floors some floor covering items like Section 8.4.16 [it_strip], page 224, Section 8.4.11 [it_meditation], page 219, may provide adhesion values as well to deviate from the floor adhesion.

Type: number
Values: any floating point number
Default: `nil`
Access: read/write
Support: by all floors, and floor covering item objects

6.1.11 checkerboard

An attribute that defines if a given object declaration should only be applied on 'even' or 'uneven' grid positions. Setting this attribute to '`0`' assures that this object will only be set on grid positions with an even sum of `x + y` grid coordinates, where as a value of '`1`' assures that the sum must be uneven. This way you can easily provide two different object declarations for a tile to generate an arbitrarily shaped map of checkerboard floors, items or stones.

Type: number
Values: `0`, `1`
Default: `nil`
Access: read/write
Support: by all floor, stone and item objects

```
          ti["c"] = ti({"fl_sahara", checkerboard=0}) .. {"fl_tigris", checkerboard=1}
```

6.1.12 rubbers

An attribute that gives you access to the Section 11.1.2 [ot_rubberband], page 330s that are currently connected to this object.

Note that this attribute is read only. You can use the rubberband references to kill or reconnect single rubberbands. But to add new rubberbands you need to use the world's '`add`' method.

Type: group of Section 11.1.2 [ot_rubberband], page 330, objects
Default: `nil`
Access: read only
Support: by actor and stone objects

6.1.13 wires

An attribute that gives you access to the Section 11.1.3 [ot_wire], page 331s that are currently connected to this stone object.

Note that this attribute is read only. You can use the wire references to kill or reconnect single wires. But to add new wires you need to use the world's '`add`' method.

Type: group of Section 11.1.3 [ot_wire], page 331, objects
Default: `nil`
Access: read only
Support: by all stone objects

6.1.14 fellows

An attribute that gives you access to the group of all objects that are currently connected either by an Section 11.1.2 [ot_rubberband], page 330, or an Section 11.1.3 [ot_wire], page 331.

Note that this attribute is read only. It is just for evaluation of the current level state. But to add new rubberbands or wires you need to use the world's '`add`' method.

Type: group of objects
Default: `nil`
Access: read only
Support: by actor and stone objects

6.2 Common Messages

6.2.1 toggle

This is the default message that is always taken if no other message is provided. It toggles the Section 4.3.4 [Object State], page 56, quite independent of the very nature of the state. Two-stated objects like switches will toggle their state form '`ON`' to '`OFF`' or from '`OFF`' to '`ON`'. Door like objects will toggle their state from '`OPEN`' to '`CLOSED`' or from '`CLOSED`' to

'`OPEN`'. Other objects like Section 9.5.25 [st_fourswitch], page 264, will turn into the next orientation. Generally the object will toggle to its next state.

Value: -

Returns: -
Support: by nearly all objects which use the '`state`' attribute

6.2.2 nop

A dummy message that just does nothing: no operation. You may need it in cases of state dependent actions to block an otherwise sent default '`toggle`' message (see Section 4.3.4 [Object State], page 56).

Value: -

Returns: -
Support: by all objects

6.2.3 signal

A signal message tries to set the object to the state 0 ('`OFF`', '`CLOSED`') or state 1 ('`ON`', '`OPEN`') according to its value. This message allows you to keep the states of an action source and a receiving object in sync. Note that values like '`true`', '`false`' and orientation values like '`WEST`' to '`NORTH`' are converted to 0 and 1. This allows you to use '`signal`' as action message on most objects.

Value: `0`, `1`
Returns: -
Support: by nearly all objects which use the '`state`' attribute

6.2.4 on

This message is just supported by objects that can be switched on and off. Just objects in state '`OFF`' will be switched on. An object in state '`ON`' remains unchanged in its state.

Value: -

Returns: -
Support: by objects that can be switched on and off

6.2.5 off

This message is just supported by objects that can be switched on and off. Just objects in state '`ON`' will be switched off. An object in state '`OFF`' remains unchanged in its state.

Value: -

Returns: -
Support: by objects that can be switched on and off

6.2.6 open

This message is just supported by door like objects that can be opened and closed. Just objects in state '`CLOSED`' will be opened. An object in state '`OPEN`' remains unchanged in its state.

Value: -

Returns: -
Support: by door like objects that can be opened and closed

6.2.7 close

This message is just supported by door like objects that can be opened and closed. Just objects in state '`OPEN`' will be closed. An object in state '`CLOSED`' remains unchanged in its state.

Value: -

Returns: -
Support: by door like objects that can be opened and closed

6.2.8 ignite

Sets fire to a floor if it is burnable (see Section 13.2.3 [Fire Spreading], page 392) or start an explosion or shattering of items like Section 8.3.11 [it_dynamite], page 192, Section 8.4.2 [it_bomb], page 211, or stones like Section 9.5.29 [st_ice], page 267, Section 9.5.18 [st_dispenser], page 257, and many more.

Value: -

Returns: -
Support: by all Chapter 7 [Floor Objects], page 148, and explosive or shattering items and stones

6.2.9 heat

Sets fire to a floor if it is burnable (see Section 13.2.3 [Fire Spreading], page 392) or causes a Section 13.2.4 [Heat-Transformation], page 394, on a floor or other objects like Section 9.5.29 [st_ice], page 267, that starts melting. Some objects do react on a heat message like on an Section 6.2.8 [ignite], page 131, message by explosions or shattering.

Value: -

Returns: -
Support: by all Chapter 7 [Floor Objects], page 148, and some other objects.

6.2.10 setfire

Sets fire to a floor if it is burnable (see Section 13.2.3 [Fire Spreading], page 392).

Value: -

Returns: -
Support: by all Chapter 7 [Floor Objects], page 148

6.2.11 kill

This message causes the recipient to cease to exist. You are just allowed to kill objects that are directly part of the world. Objects owned by players, being content part of a bag or otherwise owned by another object will refuse this message on behalf of their owner.

Value: -

Returns: -
Support: by all world owned objects

6.2.12 sound

This message causes the recipient to play the sound given by the first string argument value. It is played at the position of the object. The volume can be defined by a second number argument and defaults to `1.0`.

Value: string [, number]
Returns: -
Support: by all objects

6.2.13 disconnect

This message causes the recipient to disconnect from all Section 6.1.14 [fellows], page 129, by cutting all Section 6.1.13 [wires], page 129, and Section 6.1.12 [rubbers], page 129, that are connected to it.

Value: -

Returns: -
Support: by all objects

6.3 Common Constants

Constants for Section 5.4.4 [Pseudo Datatypes], page 89.

6.3.1 state values

Number constants for object attribute Section 6.1.2 [state], page 125. Please choose the constant that is appropriate for an object and do avoid using numbers.

- '`OFF`' = `0`, all switch like objects
- '`ON`' = `1`, all switch like objects
- '`CLOSED`' = `0`, all door like objects
- '`OPEN`' = `1`, all door like objects
- '`IDLE`' = `0`, other objects in the default passive state
- '`ACTIVE`' = `1`, other objects in the active state
- '`INACTIVE`' = `2`, other objects in the inactive state
- '`OXYDPAIR`' = `2`, just by Section 9.5.44 [st_oxyd], page 284,
- '`LIGHT`' = `0`, by Section 9.5.17 [st_disco], page 256,
- '`MEDIUM`' = `1`, by Section 9.5.17 [st_disco], page 256, Section 8.4.4 [it_crack], page 213, Section 8.3.12 [it_extinguisher], page 192,
- '`DARK`' = `2`, by Section 9.5.17 [st_disco], page 256,
- '`FLOODING`' = `1`, by Section 7.4.13 [fl_water], page 178, Section 7.4.14 [fl_wood], page 179, Section 7.4.5 [fl_hay], page 171, Section 7.4.8 [fl_rock], page 173,
- '`INVISIBLE`' = `-1`, by Section 8.4.4 [it_crack], page 213,
- '`SMALL`' = `0`, by Section 8.4.4 [it_crack], page 213,
- '`LARGE`' = `2`, by Section 8.4.4 [it_crack], page 213,
- '`YIN`' = `0`, by Section 7.4.15 [fl_yinyang], page 180, and all actors as Section 10.1.7 [owner], page 321, value

- '`YANG`' = `1`, by Section 7.4.15 [fl_yinyang], page 180, and all actors as Section 10.1.7 [owner], page 321, value
- '`EMPTY`' = `0`, by Section 8.3.12 [it_extinguisher], page 192,
- '`FULL`' = `2`, by Section 8.3.12 [it_extinguisher], page 192,
- '`BROKEN`' = `1`, by Section 8.3.3 [it_bottle], page 186,
- '`BREAKING`' = `2`, by Section 9.5.53 [st_quake], page 297,
- '`CW`' = `0`, clockwise, by Section 9.5.56 [st_rotator], page 298,
- '`CCW`' = `1`, counterclockwise, by Section 9.5.56 [st_rotator], page 298,

6.3.2 color values

Number constants for attribute Section 10.1.4 [color], page 320. Please choose the constant that is appropriate for an object and do avoid using numbers. Note that objects do support a color attribute only, if it is related to a functionality. The color of Section 9.5.44 [st_oxyd], page 284, uses another enumeration scheme due to legacy reasons, see Section 6.3.4 [oxyd colors], page 133.

- '`BLACK`' = `0`, all black/white colored objects
- '`WHITE`' = `1`, all black/white colored objects
- '`BLUE`' = `2`, by Section 9.5.52 [st_puzzle], page 292,
- '`YELLOW`' = `3`, by Section 9.5.52 [st_puzzle], page 292,
- '`NOCOLOR`' = `nil`, some objects, that exist in black, white variants, too, like Section 9.5.64 [st_switch], page 307,

6.3.3 actor controllers

Number constants for actor attribute Section 10.1.3 [controllers], page 320. Please choose the constant that is appropriate for an object and do avoid using numbers.

- '`CTRL_NONE`' = `0`, by all actors
- '`CTRL_YIN`' = `1`, by all actors
- '`CTRL_YANG`' = `2`, by all actors
- '`CTRL_YINYANG`' = `3`, by all actors

6.3.4 oxyd colors

Number constants for Section 9.5.44 [st_oxyd], page 284, attribute '`oxydcolor`'. Please choose the constant that is appropriate for an object and do avoid using numbers.

- '`OXYD_BLUE`' = `0`, by Section 9.5.44 [st_oxyd], page 284,
- '`OXYD_RED`' = `1`, by Section 9.5.44 [st_oxyd], page 284,
- '`OXYD_GREEN`' = `2`, by Section 9.5.44 [st_oxyd], page 284,
- '`OXYD_YELLOW`' = `3`, by Section 9.5.44 [st_oxyd], page 284,
- '`OXYD_CYAN`' = `4`, by Section 9.5.44 [st_oxyd], page 284,
- '`OXYD_PURPLE`' = `5`, by Section 9.5.44 [st_oxyd], page 284,
- '`OXYD_WHITE`' = `6`, by Section 9.5.44 [st_oxyd], page 284,
- '`OXYD_BLACK`' = `7`, by Section 9.5.44 [st_oxyd], page 284,

- '`OXYD_GRAY`' = `8`, by Section 9.5.44 [st_oxyd], page 284,
- '`OXYD_ORANGE`' = `9`, by Section 9.5.44 [st_oxyd], page 284,
- '`OXYD_PINE`' = `10`, by Section 9.5.44 [st_oxyd], page 284,
- '`OXYD_BROWN`' = `11`, by Section 9.5.44 [st_oxyd], page 284,
- '`OXYD_AUTO`' = `-1`, by Section 9.5.44 [st_oxyd], page 284,
- '`OXYD_FAKE`' = `-2`, by Section 9.5.44 [st_oxyd], page 284,
- '`OXYD_QUAKE`' = `-3`, by Section 9.5.44 [st_oxyd], page 284,
- '`OXYD_BOLD`' = `-4`, by Section 9.5.44 [st_oxyd], page 284,

6.3.5 orientations

Number constants for attributes '`orientation`' or '`slope`'. Please choose the constant that is appropriate for an object and do avoid using numbers.

- '`RANDOMDIR`' = `-2`, by Section 9.5.41 [st_mirror], page 278,
- '`NODIR`' = `-1`, by Section 7.4.10 [fl_slope], page 175,
- '`WEST`' = `0`, by all objects with 4 orientations
- '`SOUTH`' = `1`, by all objects with 4 orientations
- '`EAST`' = `2`, by all objects with 4 orientations
- '`NORTH`' = `3`, by all objects with 4 orientations
- '`NORTHWEST`' = `4`, by all objects with 8 orientations
- '`SOUTHWEST`' = `5`, by all objects with 8 orientations
- '`SOUTHEAST`' = `6`, by all objects with 8 orientations
- '`NORTHEAST`' = `7`, by all objects with 8 orientations

Just for Section 9.5.41 [st_mirror], page 278, another alternative orientation notation exists:

- '`BACKSLASH`' = `0`, by Section 9.5.41 [st_mirror], page 278,
- '`HORIZONTAL`' = `1`, by Section 9.5.41 [st_mirror], page 278,
- '`SLASH`' = `2`, by Section 9.5.41 [st_mirror], page 278,
- '`VERTICAL`' = `3`, by Section 9.5.41 [st_mirror], page 278,

6.3.6 direction offsets

Position constants as vectorial direction offsets. Please choose the constant that is appropriate for a calculation and do avoid using the trivial positions instead.

- '`N`' = `po(0, -1)`
- '`E`' = `po(1, 0)`
- '`S`' = `po(0, 1)`
- '`W`' = `po(-1, 0)`
- '`NE`' = `N + E`
- '`NW`' = `N + W`
- '`SE`' = `S + E`
- '`SW`' = `S + W`

- ‘NNE’ = N + NE, by Section 9.5.13 [st_chess], page 252,
- ‘ENE’ = E + NE, by Section 9.5.13 [st_chess], page 252,
- ‘ESE’ = E + SE, by Section 9.5.13 [st_chess], page 252,
- ‘SSE’ = S + SE, by Section 9.5.13 [st_chess], page 252,
- ‘SSW’ = S + SW, by Section 9.5.13 [st_chess], page 252,
- ‘WSW’ = W + SW, by Section 9.5.13 [st_chess], page 252,
- ‘WNW’ = W + NW, by Section 9.5.13 [st_chess], page 252,
- ‘NNW’ = N + NW, by Section 9.5.13 [st_chess], page 252,

6.3.7 position lists

Position list constants. Please choose the constant that is appropriate for a calculation and do avoid using the trivial position lists instead.

- ‘NEIGHBORS_4’ = `W .. S .. E .. N`
- ‘NEIGHBORS_8’ = `NEIGHBORS_4 .. NW .. SW ..SE .. NE`
- ‘NEIGHBORS_CHESS’ = `NNE .. ENE .. ESE .. SSE .. SSW .. WSW .. WNW .. NNW`

6.3.8 essentialness

Number constants for attribute Section 10.1.5 [essential], page 321. Please choose the constant that is appropriate for an object and do avoid using numbers.

- ‘DISPENSABLE’ = 0, by all actors and Section 8.4.11 [it_meditation], page 219,
- ‘INDISPENSABLE’ = 1, by all actors and Section 8.4.11 [it_meditation], page 219,
- ‘PERKIND’ = 2, by all actors

6.3.9 meditation types

Number constants for Section 8.4.11 [it_meditation], page 219, attribute Section 6.1.2 [state], page 125. Please choose the constant that is appropriate for an object and do avoid using numbers.

- ‘MEDITATION_CALDERA’ = -3, by Section 8.4.11 [it_meditation], page 219,
- ‘MEDITATION_HOLLOW’ = -2, by Section 8.4.11 [it_meditation], page 219,
- ‘MEDITATION_DENT’ = -1, by Section 8.4.11 [it_meditation], page 219,
- ‘MEDITATION_BUMP’ = 1, by Section 8.4.11 [it_meditation], page 219,
- ‘MEDITATION_HILL’ = 2, by Section 8.4.11 [it_meditation], page 219,
- ‘MEDITATION_VOLCANO’ = 3, by Section 8.4.11 [it_meditation], page 219,

6.3.10 glasses abilities

Number constants for Section 8.3.16 [it_glasses], page 195, attribute Section 6.1.2 [state], page 125, and global variable Section 6.4.9 [ExtralifeGlasses], page 140. Please use sums of the constants that are appropriate for your glasses and do avoid using numbers.

- ‘SPOT_NOTHING’ = 0, by Section 8.3.16 [it_glasses], page 195,
- ‘SPOT_DEATH’ = 1, by Section 8.3.16 [it_glasses], page 195,
- ‘SPOT_HOLLOW’ = 2, by Section 8.3.16 [it_glasses], page 195,

- ‘SPOT_ACTORIMPULSE’ = 4, by Section 8.3.16 [it_glasses], page 195,
- ‘SPOT_SENSOR’ = 8, by Section 8.3.16 [it_glasses], page 195,
- ‘SPOT_LIGHTPASSENGER’ = 16, by Section 8.3.16 [it_glasses], page 195,
- ‘SPOT_TRAP’ = 32, by Section 8.3.16 [it_glasses], page 195,

6.3.11 coinslot acceptance

Number constants for Section 9.5.14 [st_coinslot], page 253, attributes ‘interval_*’. Please choose the constant that is appropriate for the coinslot and do avoid using numbers.

- ‘COIN_IGNORE’ = -1, by Section 9.5.14 [st_coinslot], page 253,
- ‘COIN_REJECT’ = -2, by Section 9.5.14 [st_coinslot], page 253,

6.3.12 rubberband length

Number constant for Section 8.3.25 [it_rubberband], page 202, Section 9.5.57 [st_rubberband], page 299, and Section 11.1.2 [ot_rubberband], page 330, attribute ‘length’. Please choose the constant that is appropriate for the rubberband length and do avoid using numbers.

- ‘AUTOLENGTH’ = -1, by Section 8.3.25 [it_rubberband], page 202, Section 9.5.57 [st_rubberband], page 299, and Section 11.1.2 [ot_rubberband], page 330,

6.3.13 subsoil kind

Number constants for the global attribute Section 6.4.31 [SubSoil], page 145. Please choose the constant that is appropriate for the SubSoil and do avoid using numbers.

- ‘SUBSOIL_ABYSS’ = 0, by Section 8.4.7 [it_explosion], page 217,
- ‘SUBSOIL_WATER’ = 1, by Section 8.4.7 [it_explosion], page 217,
- ‘SUBSOIL_AUTO’ = 2, by Section 8.4.7 [it_explosion], page 217,

6.3.14 screen scrolling

Constants for screen scrolling global attributes Section 6.4.13 [FollowMethod], page 141, and Section 6.4.11 [FollowAction], page 140. Please choose the constants that are appropriate for screen scrolling and do avoid using numbers or position values.

- ‘FOLLOW_NO’ = 0, by global Section 6.4.13 [FollowMethod], page 141,
- ‘FOLLOW_SCROLL’ = 1, by global Section 6.4.13 [FollowMethod], page 141,
- ‘FOLLOW_FLIP’ = 2, by global Section 6.4.13 [FollowMethod], page 141,
- ‘FOLLOW_FULLSCREEN’ = po(19, 12), by global Section 6.4.11 [FollowAction], page 140,
- ‘FOLLOW_HALFSCREEN’ = po(9.5, 6), by global Section 6.4.11 [FollowAction], page 140,

6.3.15 map read directions

Constants for map read directions (see Section 5.13.7 [drawMap], page 111) and map transformations (see Section 12.4.3 [Rotating and Mirroring Maps], page 345, and Section 12.4.9 [Map Transformation], page 353). They are not numbers, to allow advanced operations on them when libmap is loaded, see Section 12.4.26 [Map Transformation Composition and Powers], page 364.

- ‘MAP_IDENT’ = no transformation

- '`MAP_ROT_CW`' = rotate map 90 degrees clockwise
- '`MAP_ROT_180`' = rotate map 180 degrees
- '`MAP_ROT_CCW`' = rotate map 90 degrees counter-clockwise
- '`MAP_FLIP_BACKSLASH`' = flip upper-left and lower-right corners
- '`MAP_FLIP_HORIZONTAL`' = flip right and left
- '`MAP_FLIP_SLASH`' = flip upper-right and lower-left corners
- '`MAP_FLIP_VERTICAL`' = flip up and down

Because map transformations are not numbers, you may not save them as attributes of objects. Instead, you have to use '`index`' and '`MAP_ALL`', see Section 12.4.25 [Map Transformation Index and MAP_ALL], page 364.

6.4 Global Attributes

6.4.1 ActorimpulseStrength

A global scalar default factor for the actorimpulse stone bumping force. This global value is only used if no object specific value is set.

Type: number
Values: float number
Default: `+200.0`
Access: read/write
Support: Section 9.5.1 [st_actorimpulse], page 242

6.4.2 AllowSingleOxyds

A global variable that enables the existence of single unmatched Section 9.5.44 [st_oxyd], page 284, stones. Setting this variable to `true` allows you to set uneven numbers of oxyd stones for fixed colors. If a level deletes or adds oxyd stones during runtime a `true` value avoids possible problems due to temporary uneven oxyd stone numbers. The default `false` value causes an error message on detection of uneven oxyd numbers.

Type: bool
Values: `true`, `false`
Default: `false`
Access: read/write
Support: Section 9.5.44 [st_oxyd], page 284

6.4.3 AllowSuicide

A global variable that enables the user to commit suicide with all owned actors by pressing '`F3`'. As this legacy feature can cause unexpected shortcuts, you can deny this freedom. A single actor suicide as committed by activation of an Section 8.3.28 [it_spoon], page 204, is not affected by this global variable.

Type: bool
Values: `true`, `false`
Default: `true`
Access: read/write
Support: no object

6.4.4 AutoRespawn

A global variable that determines, if in absence of an Section 8.3.14 [it_flag], page 194, drop given respawn position, the last recorded secure actor position should be taken instead of the starting position, in case the actor dies and is resurrected.

The recorded auto respawn position will be appropriate for common actor deaths like sinking in Section 7.4.13 [fl_water], page 178, falling into Section 7.4.1 [fl_abyss], page 166, hitting of Section 9.5.16 [st_death], page 255, slipping from an Section 8.4.16 [it_strip], page 224, being hit by an Section 8.4.9 [it_laserbeam], page 218. Even a jump into one these lethal destinations resurrects the actor onto the position from where the actor started its jump. There is no danger of being resurrected on floors without Section 7.2.1 [adhesion (floor)], page 149.

The usage of Section 8.3.14 [it_flag], page 194, in combination with AutoRespawn is fully supported. On drop of a flag, the flag position remains the valid respawn position until a flag is picked up. After a pickup of the flag, the position defined by the flag gets deleted and the AutoRespawn position gets active until a flag is dropped again.

Deaths caused by actor collisions, Section 8.4.4 [it_crack], page 213, and floor shattering explosions can lead to lethal AutoRespawn positions. Either avoid setting AutoRespawn to `true` in such cases or provide an Section 8.3.14 [it_flag], page 194, in such cases.

Shortcuts introduced by AutoRespawn are unlikely, but not generally impossible.

Type: bool
Values: `true`, `false`
Default: `false`
Access: read/write
Support: Section 10.2.4 [ac_marble], page 325, Section 10.2.5 [ac_pearl], page 326

6.4.5 ConserveLevel

A global variable that determines if a dead actor will be resurrected in case of Section 8.3.13 [it_extralife], page 193s in the gamer's inventory.

If `true`, dead actors attached to a player will be resurrected as long as extralifes are available. If a player has no living actor to control or is missing the actor's Section 10.1.5 [essential], page 321, constraints, the player is dead. The level may still continue if a second player is alive. If the gamer has an Section 8.3.35 [it_yinyang], page 209, in his inventory in single user mode, the control switches to the second player. If all players are dead, a new level game is started.

If the conserve mode is `false`, no actors will be resurrected. As soon as the player is dead and the control cannot switch to another player, all dead actors are resurrected by using extralifes, and the level is restarted without finishing the level game.

Use `false` if the level can either be not solved in case of resurrected actors or would provide a major shortcut. In all other cases, mode `true` with proper usage of actors Section 10.1.5 [essential], page 321, constraints will be preferable.

Type: bool
Values: `true`, `false`
Default: `true`
Access: read/write
Support: no objects

6.4.6 CrackSpreading

A global default value denoting the probability that a brittle floor plate, that is a floor with an Section 8.4.4 [it_crack], page 213, on top, causes direct neighboring floors to either be marked with an invisible crack or to toggle such invisible cracks to a small visible cracks. A value of `1.0` ensures that the crack spreads to the direct neighbors, a value of `0.0` prohibits the spreading to neighbor grids. Note that even if crack spreading is prohibited, existing cracks on neighbor grids may continue disintegrating due to their Section 6.4.15 [Fragility], page 141. For more details see Section 8.4.4 [it_crack], page 213.

Type: number
Values: float number between `0.0` and `1.0`
Default: `0.5`
Access: read/write
Support: Section 8.4.4 [it_crack], page 213

6.4.7 CreatingPreview

A global read only variable that indicates if the current level load is just for creating a preview thumbnail of the level or a real game play. If '`true`', you can, e.g., change the start-position of the main actor to display another part of the level in the preview, or hide objects from it. When changing the initial position, it might be advantageous to also set the Section 13.2.1 [Display Follow Strategy], page 389, to permanent smooth scrolling:

```
if wo["CreatingPreview"] then
    wo["FollowGrid"] = false
    wo["FollowMethod"] = FOLLOW_SCROLL
end
```

Type: bool
Values: `true`, `false`
Default: `false`
Access: read only
Support: object independent

6.4.8 ElectricStrength

A global scalar default factor for electrical forces. Positive numbers result in attracting forces for opposite charges and repelling forces for equal signed charges. Where as negative numbers result in repelling forces for opposite charges and attracting forces for equal signed charges. This global value is always multiplied by the charge load of the affected actors. The actor's charge load usually results from hits of Section 9.5.12 [st_charge], page 251.

Type: number
Values: float number
Default: `15.0`
Positive numbers are attracting, negative numbers are repelling.

Access: read/write
Support: Chapter 10 [Actor Objects], page 320

6.4.9 ExtralifeGlasses

A global variable that defines the Section 8.3.16 [it_glasses], page 195, type that is generated on the laser light conversion of an Section 8.3.13 [it_extralife], page 193,

Type: number

Values: positive integer number

A sum out of the constants '`SPOT_DEATH`', '`SPOT_HOLLOW`', '`SPOT_ACTORIMPULSE`', '`SPOT_SENSOR`', '`SPOT_LIGHTPASSENGER`', '`SPOT_TRAP`'

Default: `SPOT_DEATH + SPOT_HOLLOW + SPOT_LIGHTPASSENGER`

Access: read/write

Support: Section 8.3.13 [it_extralife], page 193

6.4.10 FallenPuzzle

A global object replacement kind for Section 9.5.52 [st_puzzle], page 292s fallen into Section 7.4.13 [fl_water], page 178, or Section 7.4.1 [fl_abyss], page 166. Besides any floor kind you can use any key of a tile declaration preceeded by an equal sign `'='`. By this second method you can use attributed floor kinds with special values for friction and adhesion.

Additionally you can set this global '`FallenPuzzle`' attribute to `"it_pipe"` or `"it_strip"`. In both cases fallen puzzle objects will be replaced by items of the given class with the identical connections as the fallen puzzle stones. Just in case that an item of the given class is already present at one of the affected grid positions the connections of these will be adjusted in a special way. An existing `"it_pipe"` remains unchanged, but an `"it_stip"` will add the connections of the fallen puzzle to its own connections.

Type: string

Values: any floor object kind, `"it_strip"`, `"it_pipe"` or `"=key"`, with key being a valid tile key

Default: `"fl_gray"`

Access: read/write

Support: Section 9.5.52 [st_puzzle], page 292

6.4.11 FollowAction

A global variable that describes the action of the display on relocation. This attribute is introduced for future extensions, but is currently just partially supported. Just the values listed below are used. Please use this attribute just as explained in Section 13.2.1 [Display Follow Strategy], page 389.

Type: number or position

Values: `0`, `FOLLOW_FULLSCREEN`, `HALFSCREEN`

The distance of display readjustment. Positions are used to supply different values for x and y. The value '`{19, 12}`' is a standard full screen move. The value '`{9.5, 6}`' is a standard half screen move. A value '`0`' is a minimal smooth move or the default value for grid based moves.

Default: `{19, 12}`

Actually the default is mode based (see Section 13.2.1 [Display Follow Strategy], page 389).

Access: read/write
Support: no objects

6.4.12 FollowGrid

A global variable that determines if the display is fixed in its static positions to grids or if it can be scrolled to any pixel position (see Section 13.2.1 [Display Follow Strategy], page 389).

Type: bool
Values: `true`, `false`
Default: `true`
Access: read/write
Support: no objects

6.4.13 FollowMethod

A global variable that describes the method how the display moves, either not at all, by pixelwise scrolling, or by flipping to another screen or region (see Section 13.2.1 [Display Follow Strategy], page 389).

Type: number
Values: `FOLLOW_NO`, `FOLLOW_SCROLL`, `FOLLOW_FLIP`
Default: `FOLLOW_FLIP`
Access: read/write
Support: no objects

6.4.14 FollowThreshold

A global variable that describes the threshold at which a crossing active marble triggers the display to relocate. It is given as the distance to the screen boundary (see Section 13.2.1 [Display Follow Strategy], page 389).

Type: number or position
Values: 0 or positive number, or a pair of two positive numbers
The distance from the screen boundary at which the displays readjusts. Positions are used to supply different values for x and y. All values need to be less than half of the screen size.

Default: `0.5`
Access: read/write
Support: no objects

6.4.15 Fragility

A global default value denoting the probability that a brittle floor plate, that is a floor with an Section 8.4.4 [it_crack], page 213, on top, continues to disintegrate on events like an actor entering, passing a neighboring Section 8.4.4 [it_crack], page 213, nearby explosions or fire heating. A value of `1.0` ensures that the crack continues to disintegrates on these events, a value of `0.0` prohibits visible cracks to get larger. This default is superseded by Section 7.2.9 [fragility (floor)], page 151, and Section 8.4.4 [it_crack], page 213, specific values.

Type: number
Values: float number between `0.0` and `1.0`
Default: `1.0`
Access: read/write
Support: Section 8.4.4 [it_crack], page 213, and Chapter 7 [Floor Objects], page 148

6.4.16 FrictionStrength

A global scalar default factor for floor friction values. This global value is always multiplied by the floor specific friction on calculation of the friction force applied to actors.

Type: number
Values: float number
Default: `1.0`
Access: read/write
Support: all floors

6.4.17 GlobalForce

A global constant force that is added to every actor on every grid. The force is given as a vector constant by a value of type Section 5.5 [Position], page 89.

Type: Section 5.5 [Position], page 89
Values: pair of float numbers
Default: `po(0.0, 0.0)`
Access: read/write
Support: all floors

6.4.18 Height

A global read only variable reports the height of the world in grid units. This is set by the initial world constructor call (see Section 5.13.1 [World Creation], page 108).

Type: number
Values: positive integer number
Default: `?`
Access: read only
Support: object independent

6.4.19 InfiniteReincarnation

A global variable that switches off the Section 8.3.13 [it_extralife], page 193, consumption on resurrection of a dead actor. Usually the number of extralifes is counted, the items are explicitly set or an Section 9.5.18 [st_dispenser], page 257, for extralifes is located at strategic positions. The main purpose of this flag is the support of easy modes for very lethal levels, that should give the user the opportunity to exercise difficult patterns. Usage of this flag for the regular difficult mode is deprecated.

Type: bool
Values: `true`, `false`
Default: `false`
Access: read/write
Support: object independent

6.4.20 IsDifficult

A global read only variable that defines the current difficulty mode selected by the user. All differences of easy and difficult mode within the level should be coded solely in dependence of this flag. If a level that supports an easy mode the author needs to declare it in the XML header in the element Section 3.3.7 [<modes>], page 35.

Type: bool
Values: `true`, `false`
Default: `true`
Access: read only
Support: object independent

6.4.21 MagnetRange

A global default distance up to which magnets apply forces to actors. This global value is only used if no object specific value is set.

Type: number
Values: positive float number or zero
Default: `10.0`
Access: read/write
Support: Section 8.4.10 [it_magnet], page 218

6.4.22 MagnetStrength

A global scalar default factor for magnet forces. Positive numbers are attracting forces where as negative numbers are repelling forces. This global value is only used if no object specific value is set.

Type: number
Values: float number
Default: `30.0`

Positive numbers are attracting, negative numbers are repelling.

Access: read/write
Support: Section 8.4.10 [it_magnet], page 218

6.4.23 MaxOxydColor

A global variable that limits the number of colors assigned to autocolored Section 9.5.44 [st_oxyd], page 284. Be careful with increasing this value beyond its default.

Type: number
Values: `OXYD_BLUE`, ... `OXYD_BROWN`
Default: `OXYD_BLACK`
Access: read/write
Support: Section 9.5.44 [st_oxyd], page 284

6.4.24 MeditationStrength

A global scalar default factor for Section 8.4.11 [it_meditation], page 219, slope forces. Positive numbers are downhill forces that let actors roll into dents and hollows and roll down from hills and bumps.

Type: number
Values: float number
Default: `1.0`
Access: read/write
Support: Section 8.4.11 [it_meditation], page 219

6.4.25 ProvideExtralifes

A global variable that causes two Section 8.3.13 [it_extralife], page 193s to be added to both player inventories on start of a new level. Set it to '`false`' if a gamer could misuse these items. It is important to set this attribute before the world is created (see Section 5.13.1 [World Creation], page 108).

Type: bool
Values: `true`, `false`
Default: `true`
Access: read/write
Support: object independent

6.4.26 RubberViolationStrength

A global scalar default factor for the Section 11.1.2 [ot_rubberband], page 330, force that is applied to actors if the length of the rubberband exceeds the given min or max limits. This can happen due to extraordinary events like actor warping, actor resurrection, moving anchor stones or simply new rubberbands that are created with off limit length.

Type: number
Values: positive float number
Default: `50.0`
Access: read/write
Support: Section 11.1.2 [ot_rubberband], page 330

6.4.27 ShowMoves

A global variable that enables or disables the display of the stone push counter besides the level time. It is mainly used in Sokoban like levels.

Type: bool
Values: `true`, `false`
Default: `false`
Access: read/write
Support: object independent

6.4.28 SlopeStrength

A global scalar default factor for Section 7.4.10 [fl_slope], page 175, floor gradient forces. This global value is used if no slope object specific strength factor is supplied.

Type: number
Values: float number
Default: `25.0`
Access: read/write
Support: Section 7.4.10 [fl_slope], page 175

6.4.29 SublevelNumber

A global variable that is only used by Section 3.9 [Multilevel Files], page 45. It contains the number of the sublevel that should be loaded and played. The number is preset to a value between `1` and the '`quantity`' given in the Section 3.3 [Info metadata], page 28.

Type: int
Values: positive integer numbers
Default: `1`
Access: read only
Support: no objects

6.4.30 SublevelTitle

A global variable that is only used by Section 3.9 [Multilevel Files], page 45. If the sublevel provides an individual title this variable must be set on level load to the title string. An empty string value causes an auto generated title based on the title given in the Section 3.3.1 [<identity>], page 30, element and the Section 6.4.29 [SublevelNumber], page 145.

Type: string
Values: any string
Default: `""`
Access: read/write
Support: no objects

6.4.31 SubSoil

A global variable that defines the subsoil which replaces a floor on its physical destruction. Section 8.4.2 [it_bomb], page 211s and Section 11.1.1 [ot_cannonball], page 330s can cause Section 8.4.7 [it_explosion], page 217_debris which in turn dissolves the floor to the base subsoil. The special value `SUBSOIL_AUTO` determines the subsoil based on the surrounding floors. Any Section 7.4.13 [fl_water], page 178, on a direct neighboring floor causes the floor to be replaced by water, too. Otherwise the default Section 7.4.1 [fl_abyss], page 166, will be used as replacement.

Type: int
Values: `SUBSOIL_ABYSS`, `SUBSOIL_WATER`, `SUBSOIL_AUTO`
Default: `SUBSOIL_ABYSS`
Access: read/write
Support: Section 8.4.7 [it_explosion], page 217

6.4.32 SurviveFinish

A global variable that defines if the essential actors have to survive the finish of the game (see Section 4.4.8 [Ending Conditions], page 61). With this attribute set to '`false`' a gamer can sacrifice an essential actor to finish the level in the same step in some subtle cases.

Type: bool
Values: `true`, `false`
Default: `true`
Access: read/write
Support: object independent

6.4.33 SwampSinkTime

A global default for the time it takes a static actor to sink in Section 7.4.11 [fl_swamp], page 177. Fast moving actors will need slightly more time than static actors.

Type: number or `nil`
Values: positive float number or zero or `nil`
Sink time in seconds or '`nil`' for an infinite time aka not sinking. Time values smaller than approximately 0.7 ms will be rounded down to 0 ms.

Default: `1.75`
Access: read/write
Support: Section 7.4.11 [fl_swamp], page 177

6.4.34 WaterSinkTime

A global default for the time it takes an actor to sink in Section 7.4.13 [fl_water], page 178.

Type: number or `nil`
Values: positive float number or zero or `nil`
Sink time in seconds or '`nil`' for an infinite time aka not sinking. Time values smaller than approximately 0.7 ms will be rounded down to 0 ms.

Default: `0.0`
Access: read/write
Support: Section 7.4.13 [fl_water], page 178

6.4.35 Width

A global read only variable reports the width of the world in grid units. This is set by the initial world constructor call (see Section 5.13.1 [World Creation], page 108).

Type: number
Values: positive integer number
Default: `?`
Access: read only
Support: object independent

6.4.36 WormholeRange

A global default distance up to which wormholes apply forces to actors. This global value is only used if no object specific value is set.

Type: number
Values: positive float number or zero
Default: `10.0`
Access: read/write
Support: Section 8.4.20 [it_wormhole], page 229

6.4.37 WormholeStrength

A global scalar default factor for wormhole forces. Positive numbers are attracting forces where as negative numbers are repelling forces. This global value is only used if no object specific value is set.

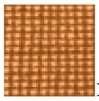
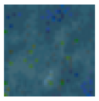
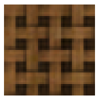
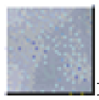
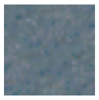
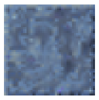
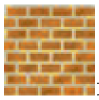
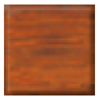
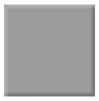
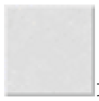
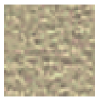
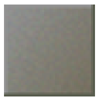
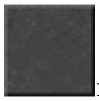
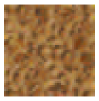
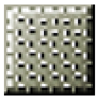
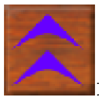
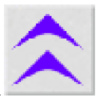
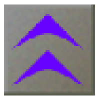
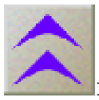
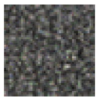
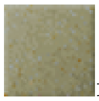
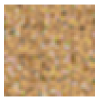
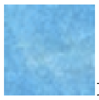
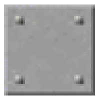
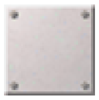
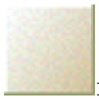
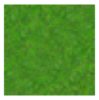
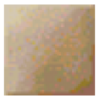
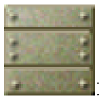
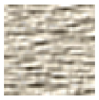
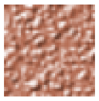
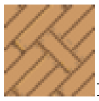
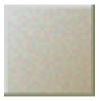
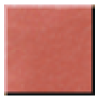
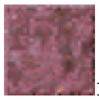
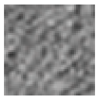
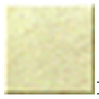
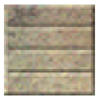
Type: number
Values: float number
Default: `30.0`

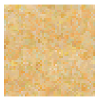
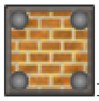
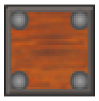
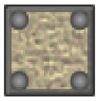
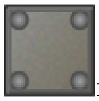
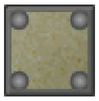
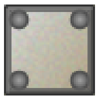
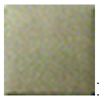
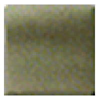
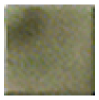
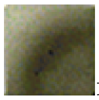
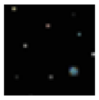
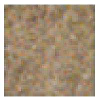
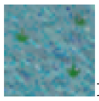
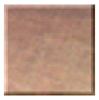
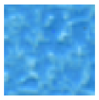
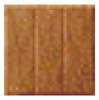
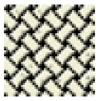
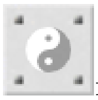
Positive numbers are attracting, negative numbers are repelling.

Access: read/write
Support: Section 8.4.20 [it_wormhole], page 229

7 Floor Objects

7.1 Floor Overview

	fl_abyss		fl_adhesionless		fl_aquamarine
	fl_bast		fl_bluegray		fl_bluegreen
	fl_blueslab		fl_brick		fl_bridge_bw
	fl_bridge_gc		fl_bright		fl_concrete
	fl_darkgray		fl_dark		fl_dunes
	fl_fake_trigger		fl_forward_bridgewood		fl_forward_bright
	fl_forward_darkgray		fl_forward_platinum		fl_forward_rough
	fl_gravel		fl_gray		fl_hay
	fl_himalaya		fl_ice		fl_inverse_gray
	fl_inverse_white		fl_ivory		fl_lawn
	fl_marble		fl_metal		fl_mortar
	fl_pinkbumps		fl_plank		fl_platinum
	fl_red		fl_redslab		fl_rock
	fl_rough		fl_sahara		fl_samba

	fl_sand		fl_scales_brick		fl_scales_bridgewood
	fl_scales_concrete		fl_scales_darkgray		fl_scales_gray
	fl_scales_platinum		fl_slope		fl_slope_ps
	fl_slope_ise		fl_slope_ose		fl_space
	fl_stone		fl_swamp		fl_thief
	fl_thief		fl_thief		fl_tigris
	fl_water		fl_white		fl_wood
	fl_woven		fl_yinyang_yang		fl_yinyang_yin

7.2 Floor Attributes

7.2.1 adhesion (floor)

The responsiveness of an actor on mouse movements. It is a scalar factor to the accelerating force applied to an actor. Note that the actor itself has another scalar Section 10.1.1 [adhesion (actor)], page 320, factor. The adhesion may take negative values, too. Such values correspond to inverse forces.

Type: number
Values: float number
Default: `0.0`
Access: read/write

7.2.2 burnable

Determines whether the floor starts to burn when a fire is nearby and the item on the floor allows it to burn. See Section 13.2.3 [Fire Spreading], page 392, for details.

Type: boolean
Values: `false`, `true`
Default: `false`
Access: read/write

7.2.3 eternal

Determines whether a fire keeps on burning unlimited, until an external cause stops it. See Section 13.2.3 [Fire Spreading], page 392, for details.

Type: boolean
Values: `false`, `true`
Default: `false`
Access: read/write

7.2.4 faces (floor)

Describes if a floor is framed.

Currently a floor is either not framed at all or framed on all sides. The frame attribute can not be directly accessed and modified on most floors. Append the string `"_framed"` to a given floor name to yield the all side framed variant.

Type: string or nil
Values: `nil`, `"nesw"`
Default: `nil`
Access: none - with a few exceptions

7.2.5 fastfire

When set to `true`, fire will spread faster than usual, with the same speed as if Section 8.4.3 [it_burnable], page 212[_oil] would be on it. See Section 13.2.3 [Fire Spreading], page 392, for details.

Type: boolean
Values: `false`, `true`
Default: `false`
Access: read/write

7.2.6 floodable

Determines whether a floor can be flooded by Section 7.4.13 [fl_water], page 178, from a neighboring floor. See Section 13.2.2 [Flood Spreading], page 390, for details.

Type: boolean
Values: `false`, `true`
Default: `false`
Access: read/write

7.2.7 force_x

A constant floor specific force into east direction applied additionally to all other forces to all actors on the floor.

Type: number
Values: float number
Default: `0.0`
Access: read/write

7.2.8 force_y

A constant floor specific force into south direction applied additionally to all other forces to all actors on the floor.

Type: number
Values: float number
Default: `0.0`
Access: read/write

7.2.9 fragility (floor)

A value denoting the probability that a brittle floor plate, that is a floor with an Section 8.4.4 [it_crack], page 213, on top, continues to disintegrate on events like an actor entering, passing a neighboring Section 8.4.4 [it_crack], page 213, nearby explosions or fire heating. A value of `1.0` ensures that the crack continues to disintegrate on these events, a value of `0.0` prohibits visible cracks to get larger. This value is defaulted by Section 6.4.15 [Fragility], page 141, and superseded by Section 8.4.4 [it_crack], page 213, specific values.

Type: number
Values: float numbers between `0.0` and `1.0`
Default: `1.0`
Access: read/write

7.2.10 freeze_check (floor)

If `true`, allows for Section 13.2.5 [Freeze Checking], page 395, on this floor tile. Note that Freeze Checking only works with those (movable) stones that have additionally set `freeze_check = true` on their own, see Section 9.2.2 [freeze_check (stone)], page 234.

Type: boolean
Values: `false`, `true`
Default: `false`
Access: read/write

7.2.11 friction (floor)

see Section 6.1.9 [friction], page 128.

Type: number
Values: float number
Default: `0.0`
Access: read/write

7.2.12 ignitable

When `true`, and the item on the floor allows it to burn, it will start burning on nearby explosions. See Section 13.2.3 [Fire Spreading], page 392, for details.

Type: boolean
Values: `false`, `true`
Default: `false`
Access: read/write

7.2.13 indestructible

Most floors can dissolve to Section 7.4.1 [fl_abyss], page 166, or Section 7.4.13 [fl_water], page 178, on destruction by explosions, fire, Section 11.1.1 [ot_cannonball], page 330, hits, Section 8.4.4 [it_crack], page 213, Section 8.4.17 [it_trap], page 226, etc. But a few like

Section 7.4.1 [fl_abyss], page 166, Section 7.4.13 [fl_water], page 178, and Section 7.4.11 [fl_swamp], page 177, are indestructible by all these events.

Type: boolean
Values: `false`, `true`
Default: `false`
Access: none

7.2.14 initfire

When set to `true`, the floor will start to burn after level initialization. See Section 13.2.3 [Fire Spreading], page 392, for details.

Type: boolean
Values: `false`, `true`
Default: `false`
Access: read/write

7.2.15 noash

Determines whether Section 8.4.3 [it_burnable], page 212_ash is put onto the floor after a fire stops. Ash stops a floor from re-igniting, so `noash = true` will allow a floor to start burning a second time, unless the item on it or its `burnable`-attribute deny fire. See Section 13.2.3 [Fire Spreading], page 392, for details.

Section 7.4.1 [fl_abyss], page 166, is the only floor with `noash = true` by default, because ash falls into the abyss. Note however, that Section 7.4.1 [fl_abyss], page 166, isn't burnable by default.

Type: boolean
Values: `false`, `true`
Default: `false`
Access: read/write

7.2.16 push_directions

A hint for the resolver Section 13.1.6 [res.puzzle], page 382, for shuffling of a puzzle. A floor marked with this attribute guarantees that an adjacent puzzle row or column can be push rotated into the listed directions by the user.

Type: string or nil
Values: `nil`, `"nesw"`
Default: `nil`
Access: read/write

7.2.17 secure

Ensures that a nearby fire eventually ignites this floor. See Section 13.2.3 [Fire Spreading], page 392, for details.

Type: boolean
Values: `false`, `true`
Default: `false`
Access: read/write

7.2.18 texture

Many floors do provide several textures - graphical image variations that are without any influence on the physical engine. Most floors do select a random texture in their default variant. This generates areas without unintended optical effects. But on some floors you can select the textures by means of variant kind names to create your own graphical floor layout.

Type: integer number or string
Values: integer number or string
Default: `1`
Access: currently none - just by varying kind strings on some floors

7.3 Standard Floors

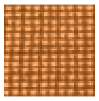
7.3.1 fl_adhesionless

Orange velvet that offers no adhesion but causes friction.

Attributes:

adhesion, *values*: number; *default*: 0.0 See Section 6.1.10 [adhesion], page 128
friction, *values*: number; *default*: 2.5 See Section 6.1.9 [friction], page 128
burnable, *values*: boolean; *default*: true See Section 7.2.2 [burnable], page 149

Variants:


fl_adhesionless

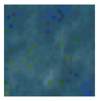
7.3.2 fl_aquamarine

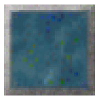
Aquamarine floor with low friction.

Attributes:

adhesion, *values*: number; *default*: 1.0 See Section 6.1.10 [adhesion], page 128
friction, *values*: number; *default*: 0.4 See Section 6.1.9 [friction], page 128
burnable, *values*: boolean; *default*: true See Section 7.2.2 [burnable], page 149

Variants:


fl_aquamarine


fl_aquamarine_framed

7.3.3 fl_bast

Brown woven bast with black background.

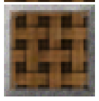
When burnt, `fl_bast` will become Section 7.4.1 [fl_abyss], page 166.

Attributes:

adhesion, *values*: number; *default*: 2.5 See Section 6.1.10 [adhesion], page 128
friction, *values*: number; *default*: 1.5 See Section 6.1.9 [friction], page 128
burnable, *values*: boolean; *default*: true See Section 7.2.2 [burnable], page 149

Variants:

fl_bast


fl_bast_framed

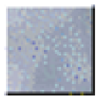
7.3.4 fl_bluegray

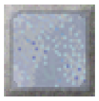
Light blue gray floor, visually indistinguishable from Section 7.4.12 [fl_thief], page 178.

Attributes:

adhesion, *values*: number; *default*: 1.5 See Section 6.1.10 [adhesion], page 128
friction, *values*: number; *default*: 4.5 See Section 6.1.9 [friction], page 128
burnable, *values*: boolean; *default*: true See Section 7.2.2 [burnable], page 149

Variants:


fl_bluegray


fl_bluegray_framed

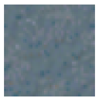
7.3.5 fl_bluegreen

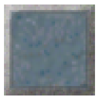
Dark blue green floor.

Attributes:

adhesion, *values*: number; *default*: 2.0 See Section 6.1.10 [adhesion], page 128
friction, *values*: number; *default*: 6.0 See Section 6.1.9 [friction], page 128
burnable, *values*: boolean; *default*: true See Section 7.2.2 [burnable], page 149

Variants:


fl_bluegreen


fl_bluegreen_framed

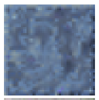
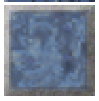
7.3.6 fl_blueslab

Dark blue slab like floor, that is marbled with black. A matching floor is Section 7.3.25 [fl_redslab], page 163.

Attributes:

adhesion, *values*: number; *default*: 2.0 See Section 6.1.10 [adhesion], page 128
friction, *values*: number; *default*: 7.0 See Section 6.1.9 [friction], page 128
burnable, *values*: boolean; *default*: true See Section 7.2.2 [burnable], page 149

Variants:


fl_blueslab

fl_blueslab_framed

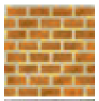
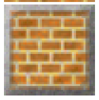
7.3.7 fl_brick

Floor composed of small red bricks.

Attributes:

adhesion, *values*: number; *default*: 2.0 See Section 6.1.10 [adhesion], page 128
friction, *values*: number; *default*: 3.5 See Section 6.1.9 [friction], page 128
burnable, *values*: boolean; *default*: false See Section 7.2.2 [burnable], page 149

Variants:


fl_brick

fl_brick_framed

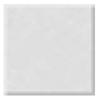
7.3.8 fl_bright

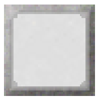
Nearly white floor without any yinyang related features. A matching floor is Section 7.3.10 [fl_dark], page 156.

Attributes:

adhesion, *values*: number; *default*: 1.5 See Section 6.1.10 [adhesion], page 128
friction, *values*: number; *default*: 3.0 See Section 6.1.9 [friction], page 128
burnable, *values*: boolean; *default*: false See Section 7.2.2 [burnable], page 149

Variants:

 **fl_bright**

 **fl_bright_framed**

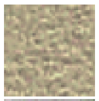
7.3.9 fl_concrete

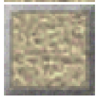
Granular gray concrete.

Attributes:

adhesion, *values*: number; *default*: 1.3 See Section 6.1.10 [adhesion], page 128
friction, *values*: number; *default*: 4.5 See Section 6.1.9 [friction], page 128
burnable, *values*: boolean; *default*: false See Section 7.2.2 [burnable], page 149

Variants:

 **fl_concrete**

 **fl_concrete_framed**

7.3.10 fl_dark

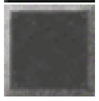
Nearly black floor without any yinyang related features. A matching floor is Section 7.3.8 [fl_bright], page 155.

Attributes:

adhesion, *values*: number; *default*: 1.5 See Section 6.1.10 [adhesion], page 128
friction, *values*: number; *default*: 3.0 See Section 6.1.9 [friction], page 128
burnable, *values*: boolean; *default*: false See Section 7.2.2 [burnable], page 149

Variants:

fl_dark

 **fl_dark_framed**

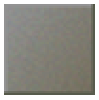
7.3.11 fl_darkgray

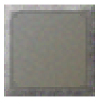
A medium to dark gray floor.

Attributes:

adhesion, *values*: number; *default*: 1.6 See Section 6.1.10 [adhesion], page 128
friction, *values*: number; *default*: 3.0 See Section 6.1.9 [friction], page 128
burnable, *values*: boolean; *default*: false See Section 7.2.2 [burnable], page 149

Variants:


fl_darkgray


fl_darkgray_framed

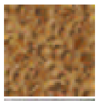
7.3.12 fl_dunes

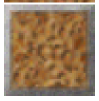
Brown granular dunes.

Attributes:

adhesion, *values*: number; *default*: 1.0 See Section 6.1.10 [adhesion], page 128
friction, *values*: number; *default*: 1.3 See Section 6.1.9 [friction], page 128
burnable, *values*: boolean; *default*: false See Section 7.2.2 [burnable], page 149

Variants:


fl_dunes


fl_dunes_framed

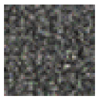
7.3.13 fl_gravel

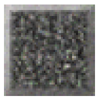
Dark gray, granular floor.

Attributes:

adhesion, *values*: number; *default*: 1.5 See Section 6.1.10 [adhesion], page 128
friction, *values*: number; *default*: 3.2 See Section 6.1.9 [friction], page 128
burnable, *values*: boolean; *default*: false See Section 7.2.2 [burnable], page 149

Variants:


fl_gravel


fl_gravel_framed

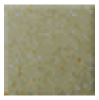
7.3.14 fl_gray

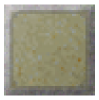
Gray with some brown spots.

Attributes:

adhesion, *values*: number; *default*: 3.0 See Section 6.1.10 [adhesion], page 128
friction, *values*: number; *default*: 5.0 See Section 6.1.9 [friction], page 128
burnable, *values*: boolean; *default*: false See Section 7.2.2 [burnable], page 149

Variants:


fl_gray


fl_gray_framed

7.3.15 fl_himalaya

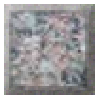
Blue purple marbled floor.

Attributes:

adhesion, *values*: number; *default*: 2.0 See Section 6.1.10 [adhesion], page 128
friction, *values*: number; *default*: 5.0 See Section 6.1.9 [friction], page 128
burnable, *values*: boolean; *default*: false See Section 7.2.2 [burnable], page 149

Variants:

fl_himalaya


fl_himalaya_framed

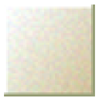
7.3.16 fl_ivory

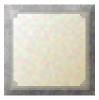
Warm ivory or pearl white floor.

Attributes:

adhesion, *values*: number; *default*: 1.6 See Section 6.1.10 [adhesion], page 128
friction, *values*: number; *default*: 2.2 See Section 6.1.9 [friction], page 128
burnable, *values*: boolean; *default*: true See Section 7.2.2 [burnable], page 149

Variants:

 **fl_ivory**

 **fl_ivory_framed**

7.3.17 fl_lawn

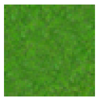
Grass floor. Light and dark grass and different textures of both exist.

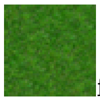
When burnt, `fl_lawn` becomes Section 7.3.12 [fl_dunes], page 157.

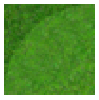
Attributes:

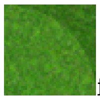
adhesion, *values*: number; *default*: 1.5 See Section 6.1.10 [adhesion], page 128
friction, *values*: number; *default*: 4.0 See Section 6.1.9 [friction], page 128
texture, *values*: `"a","b","c1","c2","c3","c4","d1","d2","d3","d4","e1","e2","e3","e4"` ; *default*: `"a"`; *access*: `none` See Section 7.2.18 [texture], page 153
burnable, *values*: boolean; *default*: true See Section 7.2.2 [burnable], page 149

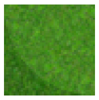
Variants:

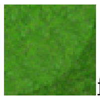
 **fl_lawn_a**: texture = ‘`"a"`’

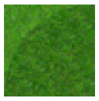
 **fl_lawn_b**: texture = ‘`"b"`’

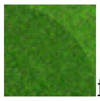
 **fl_lawn_c1**: texture = ‘`"c1"`’

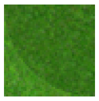
 **fl_lawn_c3**: texture = ‘`"c3"`’

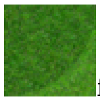
 **fl_lawn_c2**: texture = ‘`"c2"`’

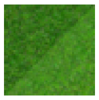
 **fl_lawn_c4**: texture = ‘`"c4"`’

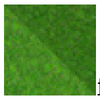
 **fl_lawn_d1**: texture = ‘`"d1"`’

 **fl_lawn_d3**: texture = ‘`"d3"`’

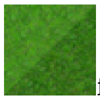
 **fl_lawn_d2**: texture = ‘`"d2"`’

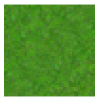
 **fl_lawn_d4**: texture = ‘`"d4"`’

 **fl_lawn_e1**: texture = ‘`"e1"`’

 **fl_lawn_e3**: texture = ‘`"e3"`’

fl_lawn_e2: texture = ‘`"e2"`’

 **fl_lawn_e4**: texture = ‘`"e4"`’

 **fl_lawn**: texture = ‘`"a"`’

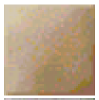
7.3.18 fl_marble

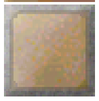
Light red brown marbled floor.

Attributes:

adhesion, *values*: number; *default*: 2.0 See Section 6.1.10 [adhesion], page 128
friction, *values*: number; *default*: 6.4 See Section 6.1.9 [friction], page 128
burnable, *values*: boolean; *default*: true See Section 7.2.2 [burnable], page 149

Variants:

 **fl_marble**

 **fl_marble_framed**

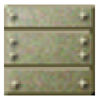
7.3.19 fl_metal

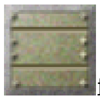
Grey metal floor with rivets. Several different textures exist with horizontal or vertical aligned joists and various rivets.

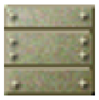
Attributes:

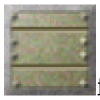
adhesion, *values*: number; *default*: 2.0 See Section 6.1.10 [adhesion], page 128
friction, *values*: number; *default*: 3.0 See Section 6.1.9 [friction], page 128
texture, *values*: integer number, 1 <= n <= 7 ; *default*: random; *access*: `none` See Section 7.2.18 [texture], page 153
burnable, *values*: boolean; *default*: false See Section 7.2.2 [burnable], page 149

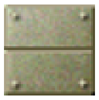
Variants:

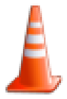
 **fl_metal**: texture = ‘`random`’

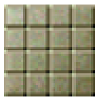
 **fl_metal_framed**: texture = ‘`random`’

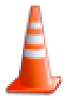
 **fl_metal_1**: texture = 1

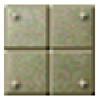
 **fl_metal_1_framed**: texture = 1

 **fl_metal_2**: texture = 2

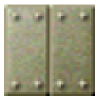
 **fl_metal_2_framed**: texture = 2

 **fl_metal_3**: texture = 3

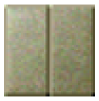
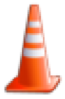
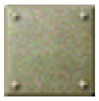
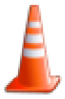
 **fl_metal_3_framed**: texture = 3

 **fl_metal_4**: texture = 4

fl_metal_4_framed: texture = 4

 **fl_metal_5**: texture = 5

fl_metal_5_framed: texture = 5

 **fl_metal_6**: texture = 6
 **fl_metal_6_framed**: texture = 6
 **fl_metal_7**: texture = 7
 **fl_metal_7_framed**: texture = 7

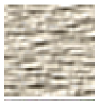
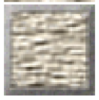
7.3.20 fl_mortar

Very rough brilliant white floor.

Attributes:

adhesion, *values*: number; *default*: 1.8 See Section 6.1.10 [adhesion], page 128
friction, *values*: number; *default*: 7.2 See Section 6.1.9 [friction], page 128
burnable, *values*: boolean; *default*: false See Section 7.2.2 [burnable], page 149

Variants:

 **fl_mortar**
 **fl_mortar_framed**

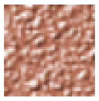
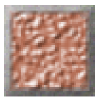
7.3.21 fl_pinkbumps

Pink floor with white bumps.

Attributes:

adhesion, *values*: number; *default*: 1.2 See Section 6.1.10 [adhesion], page 128
friction, *values*: number; *default*: 5.0 See Section 6.1.9 [friction], page 128
burnable, *values*: boolean; *default*: false See Section 7.2.2 [burnable], page 149

Variants:

 **fl_pinkbumps**
 **fl_pinkbumps_framed**

7.3.22 fl_plank

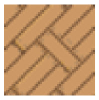
Floor build up by small diagonal orange brown planks.

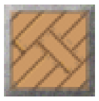
When burnt, `fl_plank` becomes Section 7.4.1 [fl_abyss], page 166.

Attributes:

adhesion, *values*: number; *default*: 2.0 See Section 6.1.10 [adhesion], page 128
friction, *values*: number; *default*: 5.5 See Section 6.1.9 [friction], page 128
burnable, *values*: boolean; *default*: false See Section 7.2.2 [burnable], page 149

Variants:


fl_plank


fl_plank_framed

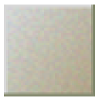
7.3.23 fl_platinum

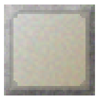
Warm light gray floor.

Attributes:

adhesion, *values*: number; *default*: 1.6 See Section 6.1.10 [adhesion], page 128
friction, *values*: number; *default*: 3.0 See Section 6.1.9 [friction], page 128
burnable, *values*: boolean; *default*: true See Section 7.2.2 [burnable], page 149

Variants:


fl_platinum


fl_platinum_framed

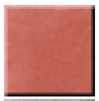
7.3.24 fl_red

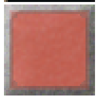
Warm red, very slippy floor.

Attributes:

adhesion, *values*: number; *default*: 1.0 See Section 6.1.10 [adhesion], page 128
friction, *values*: number; *default*: 0.9 See Section 6.1.9 [friction], page 128
burnable, *values*: boolean; *default*: true See Section 7.2.2 [burnable], page 149

Variants:


fl_red


fl_red_framed

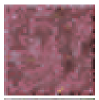
7.3.25 fl_redslab

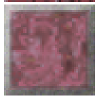
Dark red slab floor, that is marbled with black. A matching floor is Section 7.3.6 [fl_blueslab], page 155.

Attributes:

> **adhesion**, *values*: number; *default*: 2.0 See Section 6.1.10 [adhesion], page 128
> **friction**, *values*: number; *default*: 7.0 See Section 6.1.9 [friction], page 128
> **burnable**, *values*: boolean; *default*: true See Section 7.2.2 [burnable], page 149

Variants:


fl_redslab


fl_redslab_framed

7.3.26 fl_rough

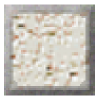
Rough warm white floor.

Attributes:

> **adhesion**, *values*: number; *default*: 2.0 See Section 6.1.10 [adhesion], page 128
> **friction**, *values*: number; *default*: 7.0 See Section 6.1.9 [friction], page 128
> **burnable**, *values*: boolean; *default*: true See Section 7.2.2 [burnable], page 149

Variants:

fl_rough


fl_rough_framed

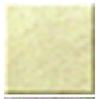
7.3.27 fl_sahara

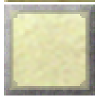
Bright yellow sandstone floor.

Attributes:

> **adhesion**, *values*: number; *default*: 2.0 See Section 6.1.10 [adhesion], page 128
> **friction**, *values*: number; *default*: 6.4 See Section 6.1.9 [friction], page 128
> **burnable**, *values*: boolean; *default*: false See Section 7.2.2 [burnable], page 149

Variants:

**fl_sahara**

**fl_sahara_framed**

7.3.28 fl_samba

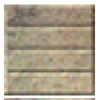
Gray bleached wooden floor. Textures with horizontal and vertical aligned plank exist.

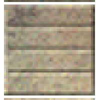
When burnt, `fl_samba` becomes Section 7.4.1 [fl_abyss], page 166.

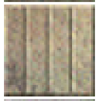
Attributes:

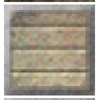
adhesion, *values*: number; *default*: 2.0 See Section 6.1.10 [adhesion], page 128
friction, *values*: number; *default*: 6.0 See Section 6.1.9 [friction], page 128
texture, *values*: `"h"`, `"v"` ; *default*: random; *access*: `none` See Section 7.2.18 [texture], page 153
burnable, *values*: boolean; *default*: true See Section 7.2.2 [burnable], page 149

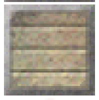
Variants:

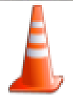
**fl_samba**: texture = ‘`random`’

**fl_samba_h**: texture = `"h"`

**fl_samba_v**: texture = `"v"`

**fl_samba_framed**: texture = ‘`random`’

**fl_samba_h_framed**: texture = `"h"`

**fl_samba_v_framed**: texture = `"v"`

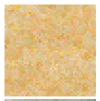
7.3.29 fl_sand

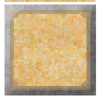
Granular orange gray sand floor.

Attributes:

adhesion, *values*: number; *default*: 2.0 See Section 6.1.10 [adhesion], page 128
friction, *values*: number; *default*: 6.0 See Section 6.1.9 [friction], page 128
burnable, *values*: boolean; *default*: false See Section 7.2.2 [burnable], page 149

Variants:


fl_sand


fl_sand_framed

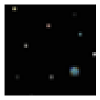
7.3.30 fl_space

Black space with a few sparkling stars. This floor has neither a friction nor does it provide an adhesion. All actors do drift for infinity on this floor until they reach another floor.

Attributes:

adhesion, *values*: number; *default*: 0.0 See Section 6.1.10 [adhesion], page 128
friction, *values*: number; *default*: 0.0 See Section 6.1.9 [friction], page 128
burnable, *values*: boolean; *default*: false See Section 7.2.2 [burnable], page 149

Variants:


fl_space

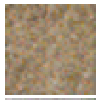
7.3.31 fl_stone

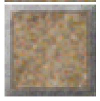
Granular brown gray floor.

Attributes:

adhesion, *values*: number; *default*: 1.0 See Section 6.1.10 [adhesion], page 128
friction, *values*: number; *default*: 1.4 See Section 6.1.9 [friction], page 128
burnable, *values*: boolean; *default*: false See Section 7.2.2 [burnable], page 149

Variants:


fl_stone


fl_stone_framed

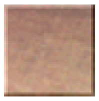
7.3.32 fl_tigris

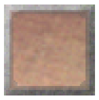
Red sandstone floor.

Attributes:

adhesion, *values*: number; *default*: 2.0 See Section 6.1.10 [adhesion], page 128
friction, *values*: number; *default*: 6.0 See Section 6.1.9 [friction], page 128
burnable, *values*: boolean; *default*: true See Section 7.2.2 [burnable], page 149

Variants:


fl_tigris


fl_tigris_framed

7.3.33 fl_white

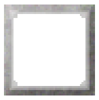
Pure white floor without any yinyang related features.

Attributes:

adhesion, *values*: number; *default*: 2.0 See Section 6.1.10 [adhesion], page 128
friction, *values*: number; *default*: 4.0 See Section 6.1.9 [friction], page 128
burnable, *values*: boolean; *default*: false See Section 7.2.2 [burnable], page 149

Variants:

fl_white


fl_white_framed

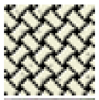
7.3.34 fl_woven

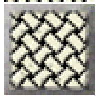
Diagonal woven white floor with black shadows.

Attributes:

adhesion, *values*: number; *default*: 3.0 See Section 6.1.10 [adhesion], page 128
friction, *values*: number; *default*: 6.5 See Section 6.1.9 [friction], page 128
burnable, *values*: boolean; *default*: true See Section 7.2.2 [burnable], page 149

Variants:


fl_woven


fl_woven_framed

7.4 Special Floors

7.4.1 fl_abyss

Pure black abyss into which all rolling balls do fall and shatter. An abyss chasm can be crossed by jumping. Section 10.2 [Actors], page 322, protected by an activated Section 8.3.32 [it_umbrella], page 207, can pass and even move on an abyss as it provides useful '`adhesion`' and '`friction`'. Another comparable floor barrier is Section 7.4.13 [fl_water], page 178.

Many floors disintegrate on fire or on a dissolving Section 8.4.4 [it_crack], page 213, into an abyss. The abyss itself is indestructible. It does neither burn nor crack.

Some stones fall into abyss, too. Section 9.5.7 [st_box], page 248, will build floors on which all actors can move and pass the former abyss filled grid.

By default, `fl_abyss` can't burn. However, when it burns (e.g. by Section 8.4.3 [it_burnable], page 212_oil), it does not create Section 8.4.3 [it_burnable], page 212_ash in the end by default (i.e., Section 7.2.15 [noash], page 152, is true by default). In particular, when `burnable` is set to `true`, an abyss may reignite arbitrarily often.

Attributes:

adhesion, *values*: number; *default*: 1.0 See Section 6.1.10 [adhesion], page 128

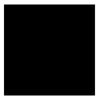
friction, *values*: number; *default*: 2.0 See Section 6.1.9 [friction], page 128

indestructible, *values*: bool ; *default*: true; *access*: `none` See Section 7.2.13 [indestructible], page 151

burnable, *values*: boolean; *default*: false See Section 7.2.2 [burnable], page 149

noash, *values*: boolean; *default*: true See Section 7.2.15 [noash], page 152

Variants:


fl_abyss

7.4.2 fl_bridge

A bridge is a variable floor that can be passed when being `CLOSED` but being impassable for marbles like Section 7.4.1 [fl_abyss], page 166, when being opened. Floor bridges come in several flavors. They can be grey or wooden brown, they can pop up in the center or emerge from one side. The flavor string is a combination of a color character and an emerging direction character. Note that not all combinations do exist.

Bridges can be opened and closed via messages and state set operations like Section 9.5.20 [st_door], page 258.

But a unique feature of bridges is to close on a solid stone being pushed onto them. Thus stones do not fall into the visible abyss of an opened bridge, but can be pushed over them. But as soon as the stone leaves the bridge it opens again. Thus a user will notice the closing and opening bridge on stone pushes.

To be more precise after a stone leaving a bridge, it switches into the state that it would have had if the stone would never have been on top of it. That means that if a stone gets pushed onto an open bridge and the bridge receives a `"close"` or `"toggle"` message while the stone is being on top the bridge remains closed when the stone is pushed away.

A bridge being set adjusts its state according to the Section 4.4.2 [Snapshot Principle], page 58. It checks for solid stones being on top of it and auto closes accordingly.

Only the brown (wooden) bridges are burnable by default. Open bridges are never burnable, regardless of the Section 7.2.2 [burnable], page 149-attribute.

Attributes:

state, *values*: `CLOSED`, `OPEN`; *default*: `OPEN` See Section 6.1.2 [state], page 125

The state as visible and responsible for the actor ability to pass.

flavor, *values*: "gc", "bw", "bs", "be", "bn"; *default*: "gc"
The type of the bridge.

adhesion, *values*: number; *default*: 1.0 See Section 6.1.10 [adhesion], page 128
friction, *values*: number; *default*: 5.0 See Section 6.1.9 [friction], page 128
burnable, *values*: boolean; *default*: depends on `flavor` See Section 7.2.2 [burnable], page 149
True if flavor is "b*", false otherwise.

Messages:

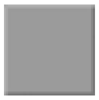
open See Section 6.2.6 [open], page 130
Opens a closed bridge that is not covered by a solid stone. Otherwise the explicit open request will be registered and executed as soon as the stone is pushed away.

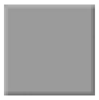
close See Section 6.2.7 [close], page 131
Closes an open bridge. If the bridge is already closed by a covering solid stone, the request will be registered and the bridge will not open when the stone is pushed away.

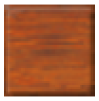
signal See Section 6.2.3 [signal], page 130
A signal of value 1 sends an open message, a signal of value 0 sends a close message.

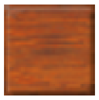
toggle See Section 6.2.1 [toggle], page 129
A toggle causes a change of the state if no stone is on top, or the registered explicit state if a solid stone currently covers the bridge.

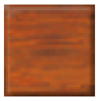
Variants:

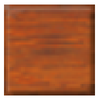

fl_bridge flavor = "gc"


fl_bridge_gc flavor = "gc"


fl_bridge_bw flavor = "bw"


fl_bridge_bs flavor = "bs"


fl_bridge_be flavor = "be"


fl_bridge_bn flavor = "bn"

7.4.3 fl_fake

A floor that mimics other floors, but does not act like them.

In contrast to Section 7.4.1 [fl_abyss], page 166, the fake abyss is just a standard floor that lets pass any actor without any harm.

A fake trigger looks similar to an Section 8.4.18 [it_trigger], page 226, but is just a standard floor without any special features.

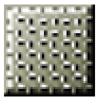
Attributes:

adhesion, *values*: number; *default*: 2.0 See Section 6.1.10 [adhesion], page 128
friction, *values*: number; *default*: 3.0 See Section 6.1.9 [friction], page 128
flavor, *values*: `"abyss"`, `"trigger"`; *default*: `"abyss"`; *access*: `none`
burnable, *values*: boolean; *default*: depends on `flavor` See Section 7.2.2 [burnable], page 149

True if flavor is `"trigger"`, false otherwise.

Variants:

 fl_fake_abyss: flavor = `"abyss"`

 **fl_fake_trigger**: flavor = `"trigger"`

7.4.4 fl_forward

The forward floor pushes stones on it in the direction it shows. In this respect, it is similar to Section 9.5.56 [st_rotator], page 298. Actors and items on it are not pushed.

Forward floors come in several flavors, which define the base floor, adhesion, friction and burnability. They all share a flashing violet double chevron, showing in the direction stones are pushed.

If the stone on top of the forward floor is blocked by another stone, it will not move. This might create race conditions. Please be very careful when using forward floors and Section 9.5.6 [st_boulder], page 246, or Section 9.5.61 [st_stoneimpulse], page 304, because race conditions might be resolved in a different way in future versions of Enigma.

Attributes:

flavor, *values*: `bridgewood`, `bright`, `darkgray`, `platinum`, `rough`
default: `darkgray`. The base floor type.

adhesion, *values*: number; *default*: depends on `flavor`
See Section 6.1.10 [adhesion], page 128.

friction, *values*: number; *default*: depends on `flavor`
See Section 6.1.9 [friction], page 128.

burnable, *values*: boolean; *default*: depends on `flavor`
See Section 7.2.2 [burnable], page 149.

True if flavor is `"bridgewood"`, false otherwise.

interval *values*: positive number; *default*: `0.6`
Number of seconds between two pushes. The interval might be 0.0, in which case the forward floor is deactivated. Otherwise, the interval must be larger or equal 0.2 seconds.

orientation, *values*: `NORTH`, `EAST`, `SOUTH`, `WEST`; *default*: `WEST`
The direction the chevron points and stones are pushed.

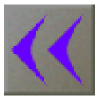
Messages:

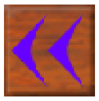
orientate, *value type*: direction
Change the current direction. The Section 9.5.25 [st_fourswitch], page 264, provides a compatible action which allows you to set a forward floor as target and this message as action.

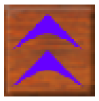
flip Turn direction into the reverse of the current direction.

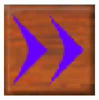
Action: none

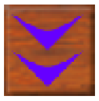
Variants:

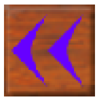

fl_forward

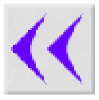

fl_forward_bridgewood: flavor = `"bridgewood"`

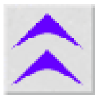

fl_forward_bridgewood_n: flavor = `"bridgewood"`, orientation = `"NORTH"`

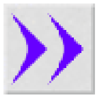

fl_forward_bridgewood_e: flavor = `"bridgewood"`, orientation = `"EAST"`

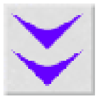

fl_forward_bridgewood_s: flavor = `"bridgewood"`, orientation = `"SOUTH"`

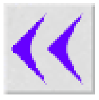

fl_forward_bridgewood_w: flavor = `"bridgewood"`, orientation = `"WEST"`

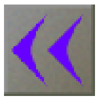

fl_forward_bright: flavor = `"bright"`

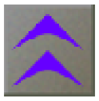

fl_forward_bright_n: flavor = `"bright"`, orientation = `"NORTH"`

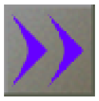

fl_forward_bright_e: flavor = `"bright"`, orientation = `"EAST"`

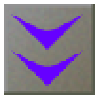

fl_forward_bright_s: flavor = `"bright"`, orientation = `"SOUTH"`

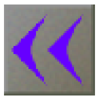

fl_forward_bright_w: flavor = `"bright"`, orientation = `"WEST"`

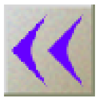

fl_forward_darkgray: flavor = `"darkgray"`

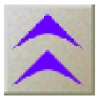

fl_forward_darkgray_n: flavor = "darkgray", orientation = "NORTH"

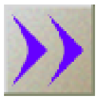

fl_forward_darkgray_e: flavor = "darkgray", orientation = "EAST"


fl_forward_darkgray_s: flavor = "darkgray", orientation = "SOUTH"

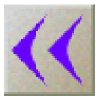

fl_forward_darkgray_w: flavor = "darkgray", orientation = "WEST"

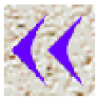

fl_forward_platinum: flavor = "platinum"

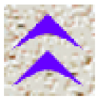

fl_forward_platinum_n: flavor = "platinum", orientation = "NORTH"

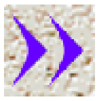

fl_forward_platinum_e: flavor = "platinum", orientation = "EAST"

fl_forward_platinum_s: flavor = "platinum", orientation = "SOUTH"

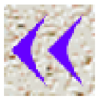

fl_forward_platinum_w: flavor = "platinum", orientation = "WEST"


fl_forward_rough: flavor = "rough"


fl_forward_rough_n: flavor = "rough", orientation = "NORTH"


fl_forward_rough_e: flavor = "rough", orientation = "EAST"

fl_forward_rough_s: flavor = "rough", orientation = "SOUTH"


fl_forward_rough_w: flavor = "rough", orientation = "WEST"

7.4.5 fl_hay

A hay floor is in most aspects a standard floor, that exists in a framed variation, too.

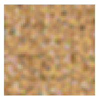
The framed variant is the successor of a fallen Section 9.5.7 [st_box], page 248_hay. It may be flooded by a Section 7.4.13 [fl_water], page 178, stream without the attribute '`floodable`' being set to '`true`' as the flood passes below this floor. The framed wood acts like a bridge over a flood stream and the water will continue to spread to neighboring grids, while the framed wood is still passable for actors. In fact a framed wood can even operate as a flood source, but we do not recommend this usage. see Section 13.2.2 [Flood Spreading], page 390.

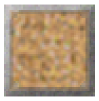
Attributes:

state, *values*: `IDLE`, `FLOODING`; *default*: `IDLE` See Section 6.1.2 [state], page 125
interval *values*: positive number; *default*: `0.2`
Number of seconds .

adhesion, *values*: number; *default*: 1.5 See Section 6.1.10 [adhesion], page 128
friction, *values*: number; *default*: 5.0 See Section 6.1.9 [friction], page 128
burnable, *values*: boolean; *default*: true See Section 7.2.2 [burnable], page 149

Variants:


fl_hay


fl_hay_framed: faces = `"nesw"`

7.4.6 fl_ice

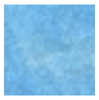
An ice floor is very slippery frozen water. The user can increase the effective friction by carrying an Section 8.3.21 [it_pin], page 198, in the player's inventory.

Ice is a standard floor in most aspects. But an Section 8.3.11 [it_dynamite], page 192, will leave an Section 8.4.4 [it_crack], page 213_water instead of a meditation hollow, and nearby fire heat will melt the ice to Section 7.4.13 [fl_water], page 178, (see Section 13.2.4 [Heat-Transformation], page 394).

Attributes:

adhesion, *values*: number; *default*: 0.1 See Section 6.1.10 [adhesion], page 128
friction, *values*: number; *default*: 0.1 See Section 6.1.9 [friction], page 128
burnable, *values*: boolean; *default*: false See Section 7.2.2 [burnable], page 149

Variants:


fl_ice

7.4.7 fl_inverse

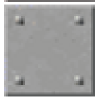
Inverse floors accelerate all actors into the opposite direction of the applied mouse input force. In all other aspects they are just standard floors.

Attributes:

adhesion, *values*: number; *default*: -2.0 See Section 6.1.10 [adhesion], page 128
friction, *values*: number; *default*: 3.0 See Section 6.1.9 [friction], page 128
flavor, *values*: `"white"`, `"gray"`; *default*: `"white"`; *access*: `none`
burnable, *values*: boolean; *default*: false See Section 7.2.2 [burnable], page 149

Variants:

fl_inverse: flavor = `"white"`

fl_inverse_white: flavor = `"white"`

fl_inverse_gray: flavor = `"gray"`

7.4.8 fl_rock

A rock floor is in most aspects a standard floor, that exists in a framed variation, too.

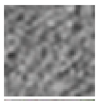
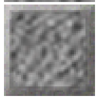
The framed variant is the successor of a fallen Section 9.5.7 [st_box], page 248_rock. It may be flooded by a Section 7.4.13 [fl_water], page 178, stream without the attribute '`floodable`' being set to '`true`' as the flood passes below this floor. The framed wood acts like a bridge over a flood stream and the water will continue to spread to neighboring grids, while the framed wood is still passable for actors. In fact a framed wood can even operate as a flood source, but we do not recommend this usage. see Section 13.2.2 [Flood Spreading], page 390.

Attributes:

state, *values*: `IDLE`, `FLOODING`; *default*: `IDLE` See Section 6.1.2 [state], page 125
interval *values*: positive number; *default*: `0.2`
Number of seconds .

adhesion, *values*: number; *default*: 2.2 See Section 6.1.10 [adhesion], page 128
friction, *values*: number; *default*: 6.5 See Section 6.1.9 [friction], page 128
burnable, *values*: boolean; *default*: false See Section 7.2.2 [burnable], page 149

Variants:


fl_rock

fl_rock_framed: faces = `"nesw"`

7.4.9 fl_scales

The scales floor is a trigger that reacts on the mass load of actors and items atop or any stones that may press it. It performs actions when it is initially pressed and again when it releases. A pressed trigger is in state '`ON`' and will send an action value of '`true`', a released trigger is in state '`OFF`' and will send an action value of '`false`'.

Only actors moving on the floor can press scales. An actor jumping over a scale will not press it. An actor jumping on a scale will release and press it again. But anyway the mass of all actors and items atop will be measured and compared to the given `min` attribute. The default triggering mass is 1.8. This mass is given by two Section 10.2.4 [ac_marble], page 325, or three Section 10.2.5 [ac_pearl], page 326. Any item like Section 8.3.33 [it_weight], page 208, or weights in an Section 8.3.1 [it_bag], page 184, that are either dropped on top of scales or carried by any actor in the player's inventory is added to the actor's basic mass.

Just solid stones will press the scales when pushed onto it. Floating, hollow stones will generally not press the scales with the exception of the hollow, central puzzle stone (see Section 9.5.52 [st_puzzle], page 292).

There is no way to set the state of a trigger manually. But the state can nevertheless be read. At initialization a scales floor that is pressed by objects will start in state '`ON`' without sending actions due to the Section 4.4.2 [Snapshot Principle], page 58.

Scales trigger with a click sound.

Scales are given in several flavors. They are similar to the Section 8.4.18 [it_trigger], page 226, in respect to their features. Visually they look similar to frames, but are well distinguishable. It is deprecated to use invisible Section 8.4.18 [it_trigger], page 226, on a framed floor as a substitution for scales.

Alternative items that react just on actors are Section 8.4.12 [it_sensor], page 221, and Section 8.4.5 [it_cross], page 215.

Attributes:

state, *values*: `ON`, `OFF`; *default*: `OFF` See Section 6.1.2 [state], page 125
The current switch state - '`ON`' for pressed scales, '`OFF`' for a released scales.

flavor, *values*: `"brick"`, `"bridgewood"`, `"concrete"`, `"darkgray"`, `"gray"`, `"platinum"`; *default*: `"darkgray"`
The base floor type of the scales.

adhesion, *values*: number; *default*: 2.0 See Section 6.1.10 [adhesion], page 128

friction, *values*: number; *default*: 4.0 See Section 6.1.9 [friction], page 128

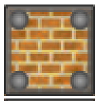
burnable, *values*: boolean; *default*: depends on `flavor` See Section 7.2.2 [burnable], page 149
True if flavor is `"bridgewood"`, false otherwise.

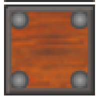
min *values*: positive float number; *default*: `+1.8`
Mass unit is the mass of an Section 10.2.4 [ac_marble], page 325,

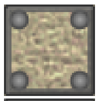
Messages: none

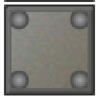
Action: See Section 6.1.3 [target], page 126, See Section 6.1.4 [action], page 126

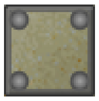
Variants:

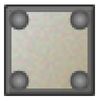

fl_scales_brick: flavor = `"brick"`


fl_scales_bridgewood: flavor = `"bridgewood"`


fl_scales_concrete: flavor = `"concrete"`


fl_scales_darkgray: flavor = `"darkgray"`


fl_scales_gray: flavor = `"gray"`


fl_scales_platinum: flavor = `"platinum"`

7.4.10 fl_slope

A floor suited to build larger hills, gradient areas, wall brims, staircases or tubes that channelize actors.

Slope floors are basically described by their '`slope`' and their '`shape`'. The slope is the orientation of the force applied to actors on top. The eight main orientations and '`NODIR`', that causes no force to be applied at all, are currently supported.

The shape describes the intended usage, which causes a proper visual representation. There are planar slopes falling just into a horizontal or vertical direction (`"pw"`, `"ps"`, `"pe"`, `"pn"`), inner and outer edges falling into a diagonal direction (`"inw"`, `"isw"`, `"ise"`, `"ine"`, `"onw"`, `"osw"`, `"ose"`, `"one"`), tube center parts falling into a horizontal or vertical direction (`"tw"`, `"ts"`, `"te"`, `"tn"`) and tube left and right sides that accelerate actors into the main tube direction and back to the tube center at the same time (`"twl"`, `"tsl"`, `"tel"`, `"tnl"`, `"twr"`, `"tsr"`, `"ter"`, `"tnr"`).

Note that several shapes do currently use an identical visual representation. But they differ in their usage and different slope force orientations are assigned by default when you use the variant suffices. It is strongly recommended to use always the shape of the intended usage as the images might be improved in the future and should fit to your level.

The force applied to actors on the floor grid is given per default by the global attribute Section 6.4.28 [SlopeStrength], page 144. You may override this default by an explicit value for the slope floor attribute '`strength`'. In very special cases you may even define individual force components '`force_x`' and '`force_y`', which will override all other slope force attributes.

Attributes:

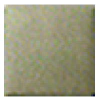
slope, *values*: `NODIR`, `WEST`, `SOUTH`, `EAST`, `NORTH`, `NORTHWEST`, `SOUTHWEST`, `SOUTHEAST`, `NORTHEAST`; *default*: `NODIR`

The orientation of the force. Note that setting this attribute does not automatically assign a fitting '`shape`'. This attribute is neglected if '`force_x`' or '`force_y`' attributes are set.

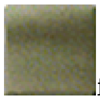
shape, *values*: `""`, `"pw"`, `"ps"`, `"pe"`, `"pn"`, `"inw"`, `"isw"`, `"ise"`, `"ine"`, `"onw"`, `"osw"`, `"ose"`, `"one"`, `"tw"`, `"ts"`, `"te"`, `"tn"`, `"twl"`, `"tsl"`, `"tel"`, `"tnl"`, `"twr"`, `"tsr"`, `"ter"`, `"tnr"`; *default*: `""`
: The intended usage as described above. Note that setting this attribute does not automatically assign the proper '`slope`'.

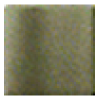
strength *values*: float number; *default*: `25.0` See Section 6.4.28 [SlopeStrength], page 144
force_x *values*: float number; *default*: `0.0` See Section 7.2.7 [force_x], page 150
force_y *values*: float number; *default*: `0.0` See Section 7.2.8 [force_y], page 150
adhesion, *values*: number; *default*: 2.0 See Section 6.1.10 [adhesion], page 128
friction, *values*: number; *default*: 4.0 See Section 6.1.9 [friction], page 128
burnable, *values*: boolean; *default*: false See Section 7.2.2 [burnable], page 149

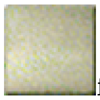
Messages: None
Variants:

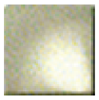

fl_slope slope = '`NODIR`', shape = `""`

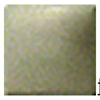
fl_slope_pw slope = '`WEST`', shape = `"pw"`

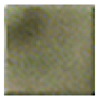

fl_slope_ps slope = '`SOUTH`', shape = `"ps"`

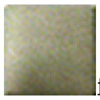

fl_slope_pe slope = '`EAST`', shape = `"pe"`

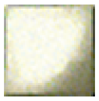

fl_slope_pn slope = '`NORTH`', shape = `"pn"`

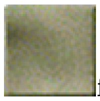

fl_slope_inw slope = '`NORTHWEST`', shape = `"inw"`

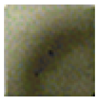

fl_slope_isw slope = '`SOUTHWEST`', shape = `"isw"`

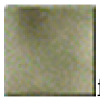

fl_slope_ise slope = '`SOUTHEAST`', shape = `"ise"`

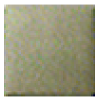

fl_slope_ine slope = '`NORTHEAST`', shape = `"ine"`

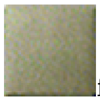

fl_slope_onw slope = '`NORTHWEST`', shape = `"onw"`

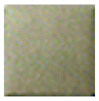

fl_slope_osw slope = '`SOUTHWEST`', shape = `"osw"`

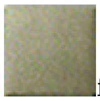

fl_slope_ose slope = '`SOUTHEAST`', shape = `"ose"`

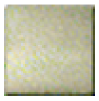

fl_slope_one slope = '`NORTHEAST`', shape = `"one"`

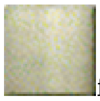

fl_slope_tw slope = ‘WEST’, shape = "tw"

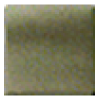

fl_slope_ts slope = ‘SOUTH’, shape = "ts"

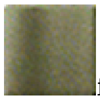

fl_slope_te slope = ‘EAST’, shape = "te"

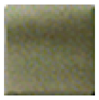

fl_slope_tn slope = ‘NORTH’, shape = "tn"

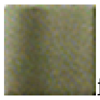

fl_slope_twl slope = ‘NORTHWEST’, shape = "twl"

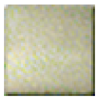

fl_slope_tsl slope = ‘SOUTHWEST’, shape = "tsl"

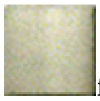

fl_slope_tel slope = ‘SOUTHEAST’, shape = "tel"


fl_slope_tnl slope = ‘NORTHEAST’, shape = "tnl"


fl_slope_twr slope = ‘SOUTHWEST’, shape = "twr"


fl_slope_tsr slope = ‘SOUTHEAST’, shape = "tsr"


fl_slope_ter slope = ‘NORTHEAST’, shape = "ter"


fl_slope_tnr slope = ‘NORTHWEST’, shape = "tnr"

7.4.11 fl_swamp

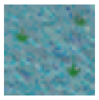
A swamp is very sticky floor caused by a high friction. Additionally ball like actors will sink in swamp. But the sink speed is limited and gives the user a certain time, defined by the global attribute Section 6.4.33 [SwampSinkTime], page 146. When an actor moves faster than 6 grids per second, the actor starts raising out of the swamp. Jumping in a swamp raises an actor, too.

A swamp is indestructible to the aspect that Section 8.4.4 [it_crack], page 213, will not spread onto it. But fire starting to burn nearby will dry out the swamp to Section 7.3.12 [fl_dunes], page 157, (see Section 13.2.4 [Heat-Transformation], page 394). A swamp itself may be a successor of a Section 7.4.13 [fl_water], page 178, heated by a fire.

Attributes:

adhesion, *values*: number; *default*: 1.0 See Section 6.1.10 [adhesion], page 128
friction, *values*: number; *default*: 13.0 See Section 6.1.9 [friction], page 128
indestructible, *values*: bool ; *default*: true; *access*: `none` See Section 7.2.13 [indestructible], page 151
burnable, *values*: boolean; *default*: false See Section 7.2.2 [burnable], page 149

Variants:


fl_swamp

7.4.12 fl_thief

A thief steals the item on its position plus an item from the player's inventory when it is entered by an owned actor. Unfortunately the thief floor is visually indistinguishable from an Section 7.3.4 [fl_bluegray], page 154, and has even the same '`friction`' and '`adhesion`' values.

The item is not directly stolen at the moment of entering the grid. The entering itself just causes the thief to emerge from his hiding-place. The thief steals from the actor that did conjure him at the moment of maximum visibility. He takes a random item from the owner's inventory. But he just will steal an item if the actor is not shielded due to an activated Section 8.3.32 [it_umbrella], page 207.

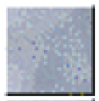
Thieves have an addiction to alcohol. Thus they get drunken and inactive if they happen to steal a bottle filled with stuff.

Thieves have an enemy - the Section 9.5.13 [st_chess], page 252. If a chess stone is pushed onto a thief it will capture the thief, sober or drunken. The thief vanishes leaving an inactive standard floor and the chess stone jumps onto its position. But the thief will leave behind on the grid all stolen items in his own Section 8.3.1 [it_bag], page 184. If the thief has not stolen any items he leaves no empty bag.

Attributes: none

adhesion, *values*: number; *default*: 1.5 See Section 6.1.10 [adhesion], page 128
friction, *values*: number; *default*: 4.5 See Section 6.1.9 [friction], page 128
burnable, *values*: boolean; *default*: false See Section 7.2.2 [burnable], page 149

Messages: none
Action: none
Variants:


fl_thief: hidden

fl_thief: showing up at the moment when stealing items

fl_thief: when being captured

fl_thief: drunken thief

7.4.13 fl_water

Besides Section 7.4.1 [fl_abyss], page 166, water is the second natural floor barrier for ball like actors, as they can not easily pass it.

Both, Section 10.2.4 [ac_marble], page 325, and Section 10.2.5 [ac_pearl], page 326, will sink in water, usually at once, but the time amount can be configured by the global attribute Section 6.4.34 [WaterSinkTime], page 146. Unlike Section 7.4.11 [fl_swamp], page 177, water does not raise fast moving actors. But jumping within water raises an actor. Jumping completely over a water chasm is of course a more standard way to cross it. Actors protected by an activated Section 8.3.32 [it_umbrella], page 207, can pass and even move on water without restrictions.

Some stones fall into water, too. Section 9.5.7 [st_box], page 248, will build floors on which all actors can move and pass the former water filled grid.

Water itself is indestructible to the aspect that Section 8.4.4 [it_crack], page 213, will not spread onto it. But a fire starting to burn nearby will dry out the water to Section 7.4.11 [fl_swamp], page 177, (see Section 13.2.4 [Heat-Transformation], page 394).

The standard water is static, its '`state`' is '`IDLE`'. It will not spread to adjacent floors. But you can set up flood streams that will fill areas or flow through given paths. You just need to define the area by setting the attribute '`floodable`' to '`true`' on the affected floors. But static water lakes do not require an additional '`floodable`' attribute, as they are floodable by default.

As soon as you add a '`fl_water_source`' or set the '`state`' to '`FLOODING`', the water starts to spread to floodable neighboring grids with a speed defined by the attribute '`interval`'. The speed will be inherited to floors flooded by a stream.

As a flood can be influenced by many obstacles and may sink some stones itself, you will find a complete discussion in the section Section 13.2.2 [Flood Spreading], page 390.

Attributes:

state, *values*: `IDLE`, `FLOODING`; *default*: `IDLE` See Section 6.1.2 [state], page 125

interval *values*: positive number; *default*: `0.2`
Number of seconds .

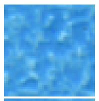
indestructible, *values*: bool ; *default*: true; *access*: `none` See Section 7.2.13 [indestructible], page 151

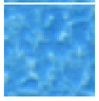
adhesion, *values*: number; *default*: 1.0 See Section 6.1.10 [adhesion], page 128

friction, *values*: number; *default*: 5.0 See Section 6.1.9 [friction], page 128

burnable, *values*: boolean; *default*: false See Section 7.2.2 [burnable], page 149

Variants:


fl_water: state = `IDLE`


fl_water_source: state = `FLOODING`

7.4.14 fl_wood

A wooden floor is in most aspects a standard floor, that exists in textures with horizontal or vertical panels, or random. All textures come in a framed variation, too.

The framed variant is the successor of a fallen Section 9.5.7 [st_box], page 248_wood. It may be flooded by a Section 7.4.13 [fl_water], page 178, stream without the attribute '`floodable`' being set to '`true`' as the flood passes below this floor. The framed wood acts like a bridge over a flood stream and the water will continue to spread to neighboring grids, while the framed wood is still passable for actors. In fact a framed wood can even operate as a flood source, but we do not recommend this usage. see Section 13.2.2 [Flood Spreading], page 390.

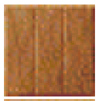
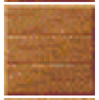
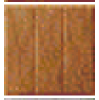
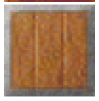
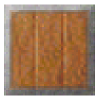
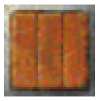
When burnt, `fl_wood` becomes Section 7.4.1 [fl_abyss], page 166.

Attributes:

state, *values*: `IDLE`, `FLOODING`; *default*: `IDLE` See Section 6.1.2 [state], page 125
interval *values*: positive number; *default*: `0.2`
Number of seconds .

adhesion, *values*: number; *default*: 2.0 See Section 6.1.10 [adhesion], page 128
friction, *values*: number; *default*: 6.4 See Section 6.1.9 [friction], page 128
burnable, *values*: boolean; *default*: true See Section 7.2.2 [burnable], page 149

Variants:


fl_wood: texture = random

fl_wood_h: texture = `"h"`

fl_wood_v: texture = `"v"`

fl_wood_framed: texture = random, faces = `"nesw"`

fl_wood_framed_h: texture = `"h"`, faces = `"nesw"`

fl_wood_framed_v: texture = `"v"`, faces = `"nesw"`

7.4.15 fl_yinyang

A floor that lets move just actors assigned to one player. A basic floor color of dark gray corresponds to '`YIN`' and lets accelerate just actors that are controlled by this first player. White colored yinyang floors correspond to '`YANG`' and let accelerate just actors controlled by this second player.

The floor image with 4 rivets in the corners shows an additional yinyang symbol to visualize that not the color of the actor is essential but the controlling player. In large areas of this floor this symbol is disturbing and it can be switched off by the attribute '`invisible`'.

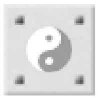
Attributes:

state, *values*: `YIN`, `YANG`; *default*: `YIN` See Section 6.1.2 [state], page 125
invisible *values*: `true`, `false`; *default*: `false`
adhesion, *values*: number; *default*: 2.0 See Section 6.1.10 [adhesion], page 128
friction, *values*: number; *default*: 5.2 See Section 6.1.9 [friction], page 128
burnable, *values*: boolean; *default*: false See Section 7.2.2 [burnable], page 149

Variants:

fl_yinyang: state = `YIN`

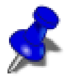
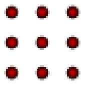
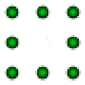
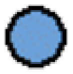
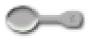
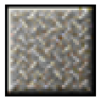
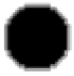
fl_yinyang_yin: state = `YIN`


fl_yinyang_yang: state = `YANG`

8 Item Objects

8.1 Item Overview

it_bag	it_banana	it_blocker
it_bomb_black	it_bomb_white	it_bottle
it_bottle_broken	it_brake	it_brush
it_burnable_ash	it_burnable_burning	it_burnable_fireproof
it_burnable_oil	it_cherry	it_coffee
it_coin_s	it_coin_m	it_coin_l
it_crack_abyss	it_crack_water	it_cross
it_death	it_document	it_drop
it_dynamite	it_explosion	it_extinguisher
it_extralife	it_flag_black	it_flag_white
it_floppy	it_glasses	it_glasses_broken
it_hammer	it_key	it_landmine
it_laserbeam	it_magicwand	it_magnet
it_meditation_bump	it_meditation_caldera	it_meditation_dent

it_meditation_hill	it_meditation_hollow	it_meditation_volcano
it_pencil	 it_pin	it_pipe
it_puller	it_ring	it_rubberband
it_seed	 it_sensor	 it_sensor_exit
 it_shogun	it_spade	 it_spoon
it_springboard	it_spring_drop	it_spring_keep
it_squashed	it_strip_ew	it_surprise
it_sword	it_trap	 it_trigger
it_umbrella	 it_vortex	it_weight
it_wormhole	it_wrench	it_yinyang

8.2 Item Attributes

8.2.1 fireproof

Type: boolean
Values: `false`, `true`
Default: `false`
Access: read/write

8.2.2 freezable

Describes the affinity of an item to be frozen by an Section 9.5.29 [st_ice], page 267. All Section 8.2.4 [portable], page 184, items a freezable. But some otherwise static items may be freezable, too.

Type: boolean
Values: `false`, `true`
Default: `false`
Access: read only

8.2.3 liftable

Describes the ability of Section 10.2 [Actors], page 322, to pick up an item from a floor. Note that some items can be added to the player's inventory and can be dropped onto a floor but nevertheless can not be picked up later on.

Type: boolean
Values: `false`, `true`
Default: `false`
Access: read only

8.2.4 portable

Determines whether an item can be added to the player's inventory. All Section 8.2.3 [liftable], page 184, items are portable. Portable items that are not liftable can either be added to the inventory by means of the world Section 5.13.5 [add], page 110, method or by an actor hitting a variant of Section 9.5.18 [st_dispenser], page 257.

Type: boolean
Values: `false`, `true`
Default: `false`
Access: read only

8.3 Liftable Items

8.3.1 it_bag

A bag is a portable container for other objects. The player can fill it with up to 13 other items, including other empty or filled bags.

The bag allows a player to carry in total more than 13 items in his inventory. Nevertheless most items carried in a bag can not directly be applied. Just the Section 8.3.33 [it_weight], page 208, does apply its mass even when carried in a bag. On the other hand bags offer the user the possibility to pick up and drop items that can not be dropped otherwise as they would be activated. E.g. an Section 8.3.6 [it_cherry], page 188, can not be dropped without application, but if it is contained in a bag the bag can be dropped and the cherry can be extracted later on. A bag is useful to transfer multiple items via Section 9.5.40 [st_mail], page 277, too.

As long as an `it_bag` is at the first place in the inventory, new items are put into the bag instead of the inventory, until the bag is full (13 items). The player can drop an `it_bag` anytime. When picked up again, items from the bag are put back into the inventory (until it is full).

The quite complex rules of pick up in detail:

1. Inventory and bag are limited concerning pickups to 13 items.
2. Both are generally LIFO (last item picked up is first item out), but the inventory content can be rotated.
3. If you pick up any item besides a bag and your first inventory item is not a bag the item is added to the inventory.

4. If you pick up any item besides a non-empty bag and your first inventory item is a bag the item is added to the first inventory bag (this includes non-empty bags being added into first inventory bags!)
5. You empty a bag by dropping it and picking it up again with any item at the first inventory position but a bag. As many items as possible are taken from the bag and added to the inventory.
6. Empty bags are never put into other bags (this would cause unresolvable recursion problems). They will only be added as items directly to the inventory.
7. If the "picked up" bag can not empty its contents to the inventory or a bag at the first inventory position is full the bag is not picked up and keeps the remaining items.

You can add items directly to a bag by usage of the world Section 5.13.5 [add], page 110, method.

Bags are used by Section 9.5.65 [st_thief], page 308, and Section 7.4.12 [fl_thief], page 178, to carry their stolen items. When the thieves are captured by Section 9.5.13 [st_chess], page 252, the bag remains on the grid position filled up with the stolen items.

Attributes:

freezable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.2 [freezable], page 183
liftable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.3 [liftable], page 184
portable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.4 [portable], page 184
mass *values*: positive float number; *default*: `0.0`; *access*: `read only`
Sum of masses of all contained items. Currently just the Section 8.3.33 [it_weight], page 208, has a mass.

Messages: none
Variants:

it_bag

8.3.2 it_banana

A portable item without direct usage. But it transforms into an Section 8.3.6 [it_cherry], page 188, when hit by a laser beam.

When a stone is pushed over it an Section 8.4.15 [it_squashed], page 224, remains as remnants.

Attributes:

freezable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.2 [freezable], page 183
liftable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.3 [liftable], page 184
portable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.4 [portable], page 184

Messages: none
Variants:

it_banana

8.3.3 it_bottle

A bottle can be filled either with booze or with a message. When a bottle breaks the remnants are lethal sherds.

A bottle filled with booze makes any ball like actor that activates it drunken. The control of actor gets difficult as it will likely no longer move straight into the intended direction. Fortunately the period of drunkenness lasts just 5 seconds per default. But you can set this time by the attribute '`interval`' to other values. The bottle will be dropped on activation. Activation of several bottles in sequence will lead to longer periods of drunkenness as the intervals will sum up.

Alternatively you can fill the bottle with a message by the attribute '`text`'. Like Section 8.3.9 [it_document], page 190, the message gets displayed on activation. Of course the actor does not get drunken in this case.

When a stone gets pushed over a bottle it will break to sherds. These remnants are lethal to Section 10.2.4 [ac_marble], page 325, and Section 10.2.5 [ac_pearl], page 326, when entering the affected grid. But of course they can jump over the broken bottle or pass it while being protected by an activated Section 8.3.32 [it_umbrella], page 207. Unlike Section 8.4.6 [it_death], page 216, the broken bottle can be removed by an actor by activation of an Section 8.3.5 [it_brush], page 188, while jumping over it, or passing it with protection. But a broken bottle can not be picked up and is not portable.

Attributes:

state, *values*: `IDLE`, `BROKEN`; *default*: `BROKEN` See Section 6.1.2 [state], page 125
interval *values*: positive number; *default*: `5.0`
Number of seconds that the actor becomes drunken.

text, *values*: string;
Either the text to be displayed or just a key word for identification on Section 3.5 [Internationalization (i18n)], page 39.

freezable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.2 [freezable], page 183
liftable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.3 [liftable], page 184
Just an '`IDLE`' bottle is liftable, a '`BROKEN`' one is not liftable.

portable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.4 [portable], page 184

Just an '`IDLE`' bottle is portable, a '`BROKEN`' one is not portable.

Messages: none
Variants:

it_bottle: state = `IDLE`

it_bottle_idle: state = `IDLE`

it_bottle_broken: state = `BROKEN`

8.3.4 it_brake

The brake is a stone that can be picked up as an item by actors. The Section 9.5.8 [st_brake], page 249, can be used to stop a running Section 9.5.6 [st_boulder], page 246, or a Section 9.5.38 [st_lightpassenger], page 275, what likely has given this object its name.

When an actor passes below the brake stone it will pick up the object like other items. The brake will be added as a brake item to its inventory. Unlike other items the brake can be dropped even on grids that are already occupied by an item. But you can not drop the brake beneath another stone like a Section 8.3.26 [it_seed], page 203.

On dropping the brake item it transforms immediately to an Section 9.5.8 [st_brake], page 249, without killing an item positioned on the grid. The brake stone will press an Section 8.4.18 [it_trigger], page 226, beneath, what makes the brake item a portable trigger key.

The item itself will never exist on the world grid. It exists just as part of the player inventory or item containers like Section 8.3.1 [it_bag], page 184.

Due to the Section 4.4.2 [Snapshot Principle], page 58, you should never instantiate this item. Do set an Section 9.5.8 [st_brake], page 249, to the world grid positions instead. This item is listed for your understanding what happens to a picked up brake and for identifying an Section 4.2.1 [Object Kind], page 49, '`it_brake`' in an inventory or a container.

Attributes:

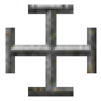
freezable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.2 [freezable], page 183

Even though being freezable a brake will never freeze as an item, as it is always converted to an Section 9.5.8 [st_brake], page 249, on being dropped or placed onto a floor.

liftable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.3 [liftable], page 184

portable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.4 [portable], page 184

Messages: none
Variants:


it_brake

8.3.5 it_brush

A brush that is useful to paint some stones and sweep away some otherwise static items.

Stones must be hit with the brush revealed as the first item in the inventory. To sweep away nasty items the actor must activate the brush while being on the grid, or while jumping or flying over it:

- Section 9.5.1 [st_actorimpulse], page 242, invisible - makes invisible variant visible
- Section 9.5.5 [st_blur], page 245, magic - transforms to Section 9.5.45 [st_passage], page 287,
- Section 9.5.23 [st_flat], page 262, burnable - transforms to Section 9.5.23 [st_flat], page 262,
- Section 9.5.23 [st_flat], page 262, moveburnable - transforms to Section 9.5.23 [st_flat], page 262_movable
- Section 9.5.26 [st_ghost], page 265, purplemarble - transforms to Section 9.3.14 [st_purplemarble], page 238,
- Section 9.5.26 [st_ghost], page 265, break - transforms to Section 9.5.9 [st_break], page 250_oxydc
- Section 9.5.38 [st_lightpassenger], page 275, off - reactivates to state '`ON`'
- Section 8.3.3 [it_bottle], page 186, broken - remove from floor
- Section 8.4.3 [it_burnable], page 212, ash - remove from floor
- Section 8.4.3 [it_burnable], page 212, fireproof - remove from floor
- Section 8.4.5 [it_cross], page 215, - remove from floor
- Section 8.4.15 [it_squashed], page 224, - remove from floor

The brush is sensitive to laser light and dissolves with an Section 8.4.7 [it_explosion], page 217_nil leaving no remnants when being hit by light.

Attributes:

freezable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.2 [freezable], page 183
liftable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.3 [liftable], page 184
portable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.4 [portable], page 184

Messages: none
Variants:

it_brush

8.3.6 it_cherry

A magic item that makes the activating actor for 8 seconds invisible. But not all actors become invisible. Just the ball like actors Section 10.2.4 [ac_marble], page 325, and Section 10.2.5 [ac_pearl], page 326, do vanish.

An invisible actor can walk through most kinds of glass (see Section 9.6.1 [Transparent Stones], page 317) and as being invisible they do no longer attract hostile Section 10.2.6 [ac_rotor], page 327, and Section 10.2.7 [ac_top], page 328.

When several cherries are activated in sequence each does prolong the actor's time of invisibility by additional 8 seconds.

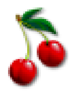
Other actors drop the cherry as an Section 8.4.15 [it_squashed], page 224, on activation. Sending a cherry via an Section 9.5.40 [st_mail], page 277, results in an Section 8.4.15 [it_squashed], page 224, too. This gives you the control that a cherry added to one player's inventory can not be easily transfered to other actors assigned to the other player. Just Section 9.5.65 [st_thief], page 308, and Section 7.4.12 [fl_thief], page 178, are able to steal the cherry undamaged.

When a stone is pushed over a cherry an Section 8.4.15 [it_squashed], page 224, remains as remnants.

Attributes:

freezable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.2 [freezable], page 183
liftable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.3 [liftable], page 184
portable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.4 [portable], page 184

Messages: none
Variants:


it_cherry

8.3.7 it_coffee

A totally passive cup of coffee. It can be picked up and be dropped many times. It blocks laser light, prohibits Section 8.4.4 [it_crack], page 213, spreading but it burns on fire and is blown away on Section 8.4.2 [it_bomb], page 211, explosions.

Attributes:

freezable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.2 [freezable], page 183
liftable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.3 [liftable], page 184
portable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.4 [portable], page 184

Messages: none
Variants:

it_coffee

8.3.8 it_coin

A coin activates an Section 9.5.14 [st_coinslot], page 253, when inserted by hitting the stone with the coin as first item in the players inventory. The time interval of activity of the coinslot depends on the coin type that is represented by its '`state`'. Small, medium and large coin variants do exist.

When hit by a moving stone the coin type changes from small to medium and from medium to large.

A laser beam transforms a small coin into an Section 8.3.32 [it_umbrella], page 207, a medium coin into an Section 8.3.17 [it_hammer], page 196, and a large coin into an Section 8.3.13 [it_extralife], page 193.

A coin that comes into existence on an illuminated grid position will not transform due to already existing laser beams. But it will transform on the first additional beam and on laser beams that are switched off and on again.

Attributes:

state, *values*: `SMALL`, `MEDIUM`, `LARGE`; *default*: `SMALL`; *access*: `read only` See Section 6.1.2 [state], page 125

Represents the coin type with '`SMALL`' being a coin of 2 cents, '`MEDIUM`' being a coin of 5 cents and '`LARGE`' being a coin of 10 cents..

freezable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.2 [freezable], page 183
liftable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.3 [liftable], page 184
portable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.4 [portable], page 184

Messages: none
Variants:

it_coin: state = `SMALL`

it_coin_s: state = `SMALL`

it_coin_m: state = `MEDIUM`

it_coin_l: state = `LARGE`

8.3.9 it_document

This item looks like a piece of paper and contains a text message that can be displayed by activating the item. It is destroyed by explosions from Section 8.4.2 [it_bomb], page 211, Section 9.5.18 [st_dispenser], page 257, Section 8.3.11 [it_dynamite], page 192, and by burning fire. The document is sensitive to laser light and dissolves with an Section 8.4.7 [it_explosion], page 217_nil leaving no remnants when being hit by light.

Other message carrying objects are Section 9.5.19 [st_document], page 258, and Section 8.3.3 [it_bottle], page 186.

Attributes:

text, *values*: string;
Either the text to be displayed or just a key word for identification on Section 3.5 [Internationalization (i18n)], page 39.

freezable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.2 [freezable], page 183
liftable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.3 [liftable], page 184
portable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.4 [portable], page 184

Messages:

ignite Burn and destroy the document.

Variants:

it_document

8.3.10 it_drop

The drop is a magic elixir for temporary actor transformations. On activation the actor transforms into another kind, lives for 5 seconds with all qualities of this kind and then transforms back to its old kind. The drop gets consumed by its activation. Generally it is not possible to prolong the transformation by activation of several drops.

Note that this object is currently just defined for the following actors:

- Section 10.2.4 [ac_marble], page 325, transforms to Section 10.2.6 [ac_rotor], page 327.

Providing a drop in a level with Section 10.2.5 [ac_pearl], page 326, will likely cause incompatibilities with future Enigma versions.

Attributes:

freezable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.2 [freezable], page 183
liftable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.3 [liftable], page 184
portable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.4 [portable], page 184

Messages: none
Variants:

it_drop

8.3.11 it_dynamite

Dynamite is an explosive that can be picked up and that can be easily ignited at any free grid position. It ignites on drop, or if positioned on the floor in '`IDLE`' state it ignites on laser light, nearby fire and other nearby explosions as those caused by Section 8.4.2 [it_bomb], page 211, Section 9.5.18 [st_dispenser], page 257, or other dynamite. A falling Section 11.1.1 [ot_cannonball], page 330, lets it explode immediately without prior ignition.

On ignition its fuse starts burning. During this '`ACTIVE`' state the dynamite can longer be picked up. After a short time the dynamite explodes causing on the 8 neighboring positions items to ignite and some stones like Section 9.5.9 [st_break], page 250, to dissolve, too. The explosion leaves at its position an Section 8.4.11 [it_meditation], page 219_hollow on all floor kinds besides Section 7.4.6 [fl_ice], page 172, where an Section 8.4.4 [it_crack], page 213_water remains.

Generally there is no direct way to stop a burning dynamite in order to prevent the explosion. It is even not allowed to reset the '`state`' attribute to '`IDLE`'. But when the user pushes an Section 9.5.29 [st_ice], page 267, over an '`ACTIVE`' dynamite it will freeze and stop burning, returning to state '`IDLE`'.

Dynamite items will be added to the inventory when an actor hits a Section 9.5.18 [st_dispenser], page 257_dynamite.

Attributes:

state, *values*: `IDLE`, `ACTIVE`; *default*: `IDLE` See Section 6.1.2 [state], page 125

freezable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.2 [freezable], page 183

liftable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.3 [liftable], page 184

portable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.4 [portable], page 184

Just '`IDLE`' dynamite can be added to the inventory, burning '`ACTIVE`' ones are not portable.

Messages:

explode	Direct explosion without burning fuse.
ignite	Ignite the fuse.
heat	Ignite the fuse.

Variants:

it_dynamite: state = `IDLE`

it_dynamite_burning: state = `ACTIVE`

8.3.12 it_extinguisher

A fire extinguisher that allows to extinguish burning fire and to protect areas with extinguishing foam of upcoming fire. See Section 13.2.3 [Fire Spreading], page 392.

A full loaded extinguisher allows two applications. The first one covers the nearest 13 grids, whereas the second one covers just 5 grids, the actor position itself and the 4 direct neighbor positions. The foam is an Section 8.4.3 [it_burnable], page 212, of kind '`fireproof`' which can be cleaned with an Section 8.3.5 [it_brush], page 188, or by a Section 13.2.2 [Flood Spreading], page 390.

The load is given by the attribute '`state`' of the extinguisher and is visible for the user by a color spot. Green is a '`FULL`' extinguisher, yellow a '`MEDIUM`' filled extinguisher and red an '`EMPTY`' extinguisher.

Extinguishers themselves are fireprotected as long as they are not empty.

The '`toggle`' message refills an extinguisher by one load until it is '`FULL`' again.

Attributes:

state, *values*: `EMPTY`, `MEDIUM`, `FULL`; *default*: `FULL` See Section 6.1.2 [state], page 125

freezable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.2 [freezable], page 183

liftable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.3 [liftable], page 184

portable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.4 [portable], page 184

Messages:

toggle See Section 6.2.1 [toggle], page 129
A toggle causes a refill by one load.

Variants:

it_extinguisher: state = `FULL`

it_extinguisher_full: state = `FULL`

it_extinguisher_medium: state = `MEDIUM`

it_extinguisher_empty: state = `EMPTY`

8.3.13 it_extralife

An extralife transforms into Section 8.3.16 [it_glasses], page 195, when hit by a laser beam and is itself a laser transformation result of an '`it_coin_l`' (see Section 8.3.8 [it_coin], page 190). The global variable Section 6.4.9 [ExtralifeGlasses], page 140, describes what the new glasses are able to spot.

An extralife that comes into existence on an illuminated grid position will not be destroyed due to already existing laser beams. But it will be destroyed on the first additional beam and on laser beams that are switched off and on again.

If another item transforms into an extralife this new extralife will be immune to light destruction for a short latency period to avoid repeated item transformations.

Attributes:

freezable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.2 [freezable], page 183

liftable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.3 [liftable], page 184

portable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.4 [portable], page 184

Variants:

it_extralife

it_extralife_new: An extralife that is immune to light destruction for a short latency period.

8.3.14 it_flag

Flags do mark the place where killed actors will be resurrected. Flags exist in two colors, '`BLACK`' and '`WHITE`'. Each can be used to define the respawn position of matching colored Section 10.2.4 [ac_marble], page 325s and Section 10.2.5 [ac_pearl], page 326s.

As a level can contain many flags of the same '`color`' the respawn position can not be defined by the flag position itself. The respawn position is the position of the last dropped flag of a given color. Additionally the respawn position gets cleared when after the last drop any flag of the same color gets picked up again. When no flag defined respawn position exists the actors will be resurrected at their initial position or the last secure position, if the global attribute Section 6.4.4 [AutoRespawn], page 138, is set to `true`.

Attributes:

color *values*: `BLACK`, `WHITE`; *default*: `BLACK`

freezable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.2 [freezable], page 183

liftable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.3 [liftable], page 184

portable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.4 [portable], page 184

Variants:

it_flag: color = `BLACK`

it_flag_black: color = `BLACK`

it_flag_white: color = `WHITE`

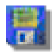
8.3.15 it_floppy

A floppy activates an Section 9.5.24 [st_floppy], page 264, when inserted by hitting the stone with the floppy as first item in the player's inventory.

Attributes:

> **freezable**, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.2 [freezable], page 183
> **liftable**, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.3 [liftable], page 184
> **portable**, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.4 [portable], page 184

Messages: none
Variants:


it_floppy

8.3.16 it_glasses

Glasses help a marble to spot certain other objects that are otherwise invisible or indistinguishable.

To be effective glasses must be hold in the top level of a player's inventory. That means that the glasses must be shown in the inventory and not be buried in an Section 8.3.1 [it_bag], page 184, that is part of the inventory. Of course glasses just help those actors that are attached to the player wearing the glasses.

Glasses can make invisible Section 9.5.16 [st_death], page 255, visible, can uncover invisible passages by making hollow stones transparent, can make inactive Section 9.5.38 [st_lightpassenger], page 275, be distinguishable from Section 9.5.15 [st_darkglass], page 254, can make invisible Section 8.4.12 [it_sensor], page 221, Section 8.4.17 [it_trap], page 226, and Section 9.5.1 [st_actorimpulse], page 242, be visible.

All these features are configurable by the constants '`SPOT_DEATH`', '`SPOT_HOLLOW`', '`SPOT_LIGHTPASSENGER`', '`SPOT_SENSOR`', '`SPOT_TRAP`' and '`SPOT_ACTORIMPULSE`'. You can set the '`state`' attribute to a sum of these constants that should apply to given glasses. The default is for backward compatibility '`SPOT_DEATH + SPOT_HOLLOW + SPOT_LIGHTPASSENGER`'. When a player wears several glasses he spots everything that any of the glasses could spot.

Glasses break when a stone is pushed over them. Broken glasses spot nothing.

Glasses result from the laser light transformation of Section 8.3.13 [it_extralife], page 193. The features of such new glasses are determined by the global variable Section 6.4.9 [ExtralifeGlasses], page 140.

Attributes:

> **state**, *values*: positive numbers; *default*: `SPOT_DEATH + SPOT_HOLLOW + SPOT_LIGHTPASSENGER` See Section 6.1.2 [state], page 125
>
> A sum of the constants '`SPOT_DEATH`', '`SPOT_HOLLOW`', '`SPOT_LIGHTPASSENGER`', '`SPOT_SENSOR`', '`SPOT_ACTORIMPULSE`', '`SPOT_TRAP`'. '`SPOT_NOTHING`' is the state of a broken glasses.

freezable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.2 [freezable], page 183
liftable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.3 [liftable], page 184
portable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.4 [portable], page 184

Messages: none
Variants:

it_glasses Active glasses item.

it_glasses_broken Broken glasses that spot nothing.

8.3.17 it_hammer

The hammer is used to destroy some stones, see Section 9.6.2 [Breakable Stones], page 319, and Section 9.5.38 [st_lightpassenger], page 275.

It transforms into Section 8.3.31 [it_sword], page 206, when hit by a laser beam and is itself a laser transformation result of an Section 8.3.31 [it_sword], page 206, and an '`it_coin_m`' (see Section 8.3.8 [it_coin], page 190).

An hammer that comes into existence on an illuminated grid position will not transform due to already existing laser beams. But it will transform on the first additional beam and on laser beams that are switched off and on again.

If another item transforms into an hammer this new hammer will be immune to further light transformations for a short latency period to avoid unstable flickering of repeated item transformations.

Attributes:

freezable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.2 [freezable], page 183
liftable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.3 [liftable], page 184
portable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.4 [portable], page 184

Variants:

it_hammer A standard hammer item.

it_hammer_new A hammer that is immune to light transformations for a short latency period.

8.3.18 it_key

A key activates an Section 9.5.32 [st_key], page 271, when inserted by hitting the stone with the key as first item in the player's inventory.

Usually the '`code`' of the key is not visually unveiled. But if you set '`invisible`' to the value '`false`' the code becomes visible for number code values '`1`' to '`8`'. The code is just visible, when the key is part of the inventory. This helps the user to distinguish multiple keys in the inventory and to assign them to the matching Section 9.5.32 [st_key], page 271s.

An '`invisible`' key reveals its code when being inserted in a matching, unveiled Section 9.5.32 [st_key], page 271. The code remains visible, when the user withdraws the key from the stone and adds it to his inventory.

Attributes:

code, *values*: number or string; *default*: `1`
The code of a key must match that of an Section 9.5.32 [st_key], page 271, to unlock it.

invisible *values*: `true`, `false`; *default*: `true`
A visible key unveils its '`code`' by a color spot when being lifted.

freezable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.2 [freezable], page 183
liftable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.3 [liftable], page 184
portable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.4 [portable], page 184

Messages: none
Variants:

it_key

8.3.19 it_magicwand

The wizard's tool, that allows to do all sort of magic things if it is the wielded item in the player's inventory:

- Section 9.5.5 [st_blur], page 245, magic - transforms to Section 9.5.45 [st_passage], page 287,
- Section 9.5.6 [st_boulder], page 246, - changes orientation of a boulder,
- Section 9.5.13 [st_chess], page 252, - changes the color of a chess stone,
- Section 9.5.26 [st_ghost], page 265, greenbrown - transforms to Section 9.5.28 [st_greenbrown], page 267,
- Section 9.5.39 [st_magic], page 276, brick - transforms to a Section 9.5.54 [st_rawglass], page 298,
- Section 9.5.43 [st_oneway], page 282, - changes orientation of a oneway,
- Section 9.5.52 [st_puzzle], page 292, - scrambles blue puzzle stones instead of pushing, causes complete clusters to explode,
- Section 9.5.57 [st_rubberband], page 299, - makes rubberband stones movable,
- Section 9.5.61 [st_stoneimpulse], page 304, movable - avoid pulsing on pushes.

Attributes:

> **freezable**, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.2 [freezable], page 183
> **liftable**, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.3 [liftable], page 184
> **portable**, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.4 [portable], page 184

Messages: none
Action: none
Variants:

it_magicwand

8.3.20 it_pencil

An item to mark floors and stones.

An activated pencil scratches an Section 8.4.5 [it_cross], page 215, on most floors. As the pencil gets consumed by this operation the cross takes the pencils identity on this Section 4.4.4 [Object Transformation], page 60. But on Section 7.4.6 [fl_ice], page 172, the pencil makes a small Section 8.4.4 [it_crack], page 213, as it is so sharp. On indestructible floors like Section 7.4.1 [fl_abyss], page 166, Section 7.4.13 [fl_water], page 178, and Section 7.4.11 [fl_swamp], page 177, and on Section 7.4.2 [fl_bridge], page 167, the pencil can not be activated at all. Any existing item on the floor does prevent a pencil application, too. The actor can only mark a floor if it is on the floor and not flying. During a jump an actor will just drop the pencil as an item.

On actor hits with a revealed pencil on a Section 9.5.23 [st_flat], page 262, the stones gets marked burnable. Again the pencil is consumed on this operation. Both the plain and the movable variants can be marked.

Attributes:

> **freezable**, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.2 [freezable], page 183
> **liftable**, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.3 [liftable], page 184
> **portable**, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.4 [portable], page 184

Messages: none
Variants:

it_pencil

8.3.21 it_pin

A pin is a friction increasing item that can be used as a crampon on Section 7.4.6 [fl_ice], page 172. When it is picked up and is added to the inventory it significantly increases the floor friction applied to all actors owned by the inventory's owner.

Pins do just increase friction as long as they are directly part of the inventory. A pin contained within an Section 8.3.1 [it_bag], page 184, being part of the inventory, has no influence on the friction. Two or more pins do not apply more friction than a single pin. As soon as the last pin is dropped the friction returns to its standard values.

Attributes:

freezable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.2 [freezable], page 183
liftable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.3 [liftable], page 184
portable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.4 [portable], page 184

Messages: none
Variants:

it_pin

8.3.22 it_pipe

Pipe items are used to build item transporting pipes connected to an Section 9.5.40 [st_mail], page 277.

Pipe items are described by their '`connections`' to neighbor grids. A pipe is build up of items with fitting connections.

Even though there exist pipe ending items with just one connection there is currently no known usage of them besides decoration.

Attributes:

connections, *values*: string; *default*: `"ew"`
Describes the pipe connections to the neighbor grids. The string is a substring of `"nesw"` listing the existing connections. The sequence of the sides, north, east, south, west, is guaranteed on read access but arbitrary on write access. Currently only pipes with one or two connections do exist.

freezable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.2 [freezable], page 183
liftable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.3 [liftable], page 184
portable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.4 [portable], page 184

Messages: none
Action: none
Variants:

it_pipe connections = "ew" The horizontal pipe.

it_pipe_w connections = "w"

it_pipe_s connections = "s"

it_pipe_sw connections = "sw"

it_pipe_e connections = "e"

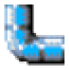
it_pipe_ew connections = "ew" The horizontal pipe.

it_pipe_es connections = "es"

it_pipe_n connections = "n"

it_pipe_nw connections = "nw"

it_pipe_ns connections = "ns" The vertical pipe.


it_pipe_ne connections = "ne"

8.3.23 it_puller

A puller item looks like a white arrow. It can be picked up. But when being dropped it gets activated and whirls around. The actor should leave the grid immediately as the puller will finally dissolve in a lethal explosion.

But the main purpose of the puller is its ability to pull stones. The arrow '`orientation`' indicates the direction into which a stone will be pulled when the item is dropped in front. The pull takes place immediately at the end of the short explosion. It is a full blown stone pull, that will pull others stones connected to the directly affected stone via Section 11.1.3 [ot_wire], page 331, too. With the explosion the puller item ceases to exist.

Attributes:

> **orientation**, *values*: `NORTH`, `EAST`, `SOUTH`, `WEST`; *default*: `WEST`
> **freezable**, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.2 [freezable], page 183
> **liftable**, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.3 [liftable], page 184
> **portable**, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.4 [portable], page 184

Messages: none
Action: none
Variants:

it_puller orientation = `WEST`

it_puller_w orientation = `WEST`

it_puller_s orientation = `SOUTH`

it_puller_e orientation = `EAST`

it_puller_n orientation = `NORTH`

8.3.24 it_ring

The ring is a magic position exchange item. On activation the ring gets dropped onto the grid and the actor gets warped either to the actors respawn position or to the position of another actor that is warped to the initiators position in exchange.

Note that this object is currently just defined in the following cases:

- just one arbitrary actor owned by player '`YIN`' - the actor gets warped to its respawn position.
- just an Section 10.2.4 [ac_marble], page 325_black owned by player '`YIN`' and an Section 10.2.4 [ac_marble], page 325_white owned by player '`YANG`' - both actors exchange their position.

Providing a ring in any other case will likely cause incompatibilities with future Enigma versions.

Attributes:

freezable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.2 [freezable], page 183
liftable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.3 [liftable], page 184
portable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.4 [portable], page 184

Messages: none
Variants:

it_ring

8.3.25 it_rubberband

A portable Section 11.1.2 [ot_rubberband], page 330, that gets connected to the bearer on activation.

As the rubberband's '`anchor1`' is given by the activator itself, just the '`anchor2`' reference can be configured by this item. It can be any stone or actor reference.

Of special interest may be the usage of dynamic nearest object references (see Section 4.2.3 [Object Naming], page 50). A marble will be able to connect to the nearest object out of a given group.

If '`anchor2`' does not exist, the '`it_rubberband`' will be dropped.

The other attributes describe the force and length parameters of the Section 11.1.2 [ot_rubberband], page 330, that will be created on application of the item. In fact the item's identity will be transferred to its successor (see Section 4.4.4 [Object Transformation], page 60). After creation of the life rubberband the action message will be send to the target. Note that it is actually the Section 11.1.2 [ot_rubberband], page 330, as the successor that sends the message.

Attributes:

anchor2 *values*: actor or stone object; *default*: `nil`
Object reference or name of an actor or a stone that the rubber will be connected to. The reference will be evaluated on item activation.

strength *values*: number; *default*: `10.0`
The force strength.

length *values*: positive number or `AUTOLENGTH`; *default*: `1.0`
The natural length above which forces are applied.

threshold *values*: positive number or zero; *default*: `0.0`
The length smaller than the natural length below which inverted forces are applied.

min *values*: positive number or zero; *default*: `0.0`
The minimum length at which actors bounce.

max *values*: positive number or zero; *default*: `0.0`
The maximum length at which actors bounce.

scissor *values*: `true`, `false`; *default*: `false`
: Rubberband cutting behaviour on connection. On a value of `true` the activation of this rubberband will cut all existing rubberbands which are currently connected to the activating actor.

freezable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.2 [freezable], page 183
liftable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.3 [liftable], page 184
portable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.4 [portable], page 184

Messages: none
Action: See Section 6.1.3 [target], page 126, See Section 6.1.4 [action], page 126
On successful activation of this item the action message is send with a value of '`true`'. Note that the parameter '`sender`' will report the new Section 11.1.2 [ot_rubberband], page 330.

Variants:

it_rubberband

8.3.26 it_seed

Stone seeds are items that start growing and finally transforming to stones on activation. There are different '`flavor`'s of seeds that all look the same, but do grow to different stones. While a `"wood"` seed grows to an Section 9.5.7 [st_box], page 248_wood, a `"hay"` seed grows to an Section 9.5.7 [st_box], page 248_hay, a `"greenbrown"` seed grows to an unmovable Section 9.5.28 [st_greenbrown], page 267, and a `"volcano"` seed grows to an active Section 9.5.69 [st_volcano], page 312.

Seeds can be dropped on any item free grid position, even beneath another stone that will get killed by the seed successor stone.

Seeds get automatically activated when being dropped, when hit by a laser beam or a stone being pushed on them. You can activate them by '`grow`' and '`signal`' messages, too.

The identity of the seed gets transferred to the emerging stone including the attribute '`secure`'.

The only method of handling seeds without activation are containment within a Section 8.3.1 [it_bag], page 184, or sending them via Section 9.5.40 [st_mail], page 277, to a destination grid.

Attributes:

flavor, *values*: `"wood"`, `"hay"`, `"greenbrown"`, `"volcano"`; *default*: `"wood"`
: The type of the resulting stone.

secure *values*: `true`, `false`; *default*: `false`
: This attribute is transferred to the resulting stone. The Section 9.5.69 [st_volcano], page 312, and Section 9.5.7 [st_box], page 248, make use of it.

freezable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.2 [freezable], page 183
liftable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.3 [liftable], page 184
portable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.4 [portable], page 184

Messages:

grow Start growing the seed.

signal See Section 6.2.3 [signal], page 130
Start growing the seed.

Variants:

it_seed flavor = `"wood"`

it_seed_wood flavor = `"wood"`

it_seed_hay flavor = `"hay"`

it_seed_greenbrown flavor = `"greenbrown"`

it_seed_volcano flavor = `"volcano"`

8.3.27 it_spade

A spade activated while being on the grid position of an Section 8.4.11 [it_meditation], page 219, will flatten this by one degree and will finally eliminate it completely.

Attributes:

freezable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.2 [freezable], page 183
liftable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.3 [liftable], page 184
portable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.4 [portable], page 184

Messages: none
Variants:

it_spade

8.3.28 it_spoon

Dropping a spoon is a medieval synonym for dying. The poor people had nothing besides a wooden spoon. They never dropped it. They had to peg out to give away their spoon.

Thus an Enigma spoon shatters the actor who drops it. When a player owns multiple actors just the active one gets killed. This is an essential difference to pressing F3, what shatters all actors of all players. When providing a spoon you may sometimes want to revoke the ability to commit a global suicide by pressing F3. You can do this by setting the global variable Section 6.4.3 [AllowSuicide], page 137, to '`false`'.

Attributes:

freezable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.2 [freezable], page 183
liftable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.3 [liftable], page 184
portable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.4 [portable], page 184

Messages: none
Variants:

it_spoon

8.3.29 it_spring

Springs let Section 10.3.1 [Flying Actors], page 329, jump on activation.

There are two types of portable springs. A thin one that is kept in the inventory on activation and can thus be used multiple times in sequence. And a thick, condensed one that gets dropped on activation. A static jump facility that can not be picked up by an actor is the Section 8.4.14 [it_springboard], page 223.

Attributes:

freezable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.2 [freezable], page 183
liftable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.3 [liftable], page 184
portable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.4 [portable], page 184

Messages: none
Variants:

it_spring

it_spring_keep

it_spring_drop

8.3.30 it_surprise

An item that transforms into a random item as soon as the player drops it.

The replacement item is a random one out of a given selection. You can set the '`selection`' attribute with tokens of strings. Every string needs either to be an Section 4.2.1 [Object Kind], page 49, or a tile key prefixed by an equal sign '`=`'.

```
ti["m"] = {"it_magicwand"}
ti["e"] = {"it_extralife"}
ti["s"] = {"it_surprise", selection={"it_seed", "=m", "=e", "=e"}}
```

The replacement item is randomly chosen out of the given selection. By listing an item several times you can take influence on the likelihood.

The tile declarations referenced by a key may even contain objects besides items. But you should make rare and proper usage of this feature.

The surprise item will perform its action after being dropped but before being replaced. You can use this action to modify the selection or to set objects on your own.

The surprise item is killed by any replacement item set to the grid position. If your selection does not resolve to an item you may need to add '`"it_nil"`' to the replacement tile declaration.

Attributes:

selection, *values*: tokens of item kinds and tile keys; *default*: `{"it_umbrella", "it_spring_keep", "it_dynamite", "it_coffee", "it_hammer"}`
freezable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.2 [freezable], page 183
liftable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.3 [liftable], page 184
portable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.4 [portable], page 184

Messages:

Action: See Section 6.1.3 [target], page 126, See Section 6.1.4 [action], page 126
Variants:

it_surprise

8.3.31 it_sword

The sword is used to neutralize Section 9.5.33 [st_knight], page 272.

It transforms into Section 8.3.17 [it_hammer], page 196, when hit by a laser beam and is itself a laser transformation result of an Section 8.3.17 [it_hammer], page 196.

A sword that comes into existence on an illuminated grid position will not transform due to already existing laser beams. But it will transform on the first additional beam and on laser beams that are switched off and on again.

If another item transforms into a sword this new sword will be immune to further light transformations for a short latency period to avoid unstable flickering of repeated item transformations.

Attributes:

freezable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.2 [freezable], page 183
liftable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.3 [liftable], page 184
portable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.4 [portable], page 184

Variants:

it_sword A standard sword item.

it_sword_new A sword that is immune to light transformations for a short latency period.

8.3.32 it_umbrella

An activated umbrella temporarily protects a marble from Section 9.5.16 [st_death], page 255, Section 9.5.33 [st_knight], page 272, Section 9.5.65 [st_thief], page 308, Section 7.4.1 [fl_abyss], page 166, Section 7.4.13 [fl_water], page 178, Section 7.4.11 [fl_swamp], page 177, Section 7.4.12 [fl_thief], page 178, Section 8.4.6 [it_death], page 216, Section 8.4.17 [it_trap], page 226, broken Section 8.3.3 [it_bottle], page 186, explosions, moving stones and all other internal '`shatter`' and '`fall`' events; in other words, from all lethal situations and thieves. The protection lasts for 10 seconds. Multiple umbrellas activated in sequence will prolong the protection period.

An umbrella gets destroyed when hit by a laser beam and is itself a laser transformation result of an '`it_coin_s`'(see Section 8.3.8 [it_coin], page 190).

An umbrella that comes into existence on an illuminated grid position will not be destroyed due to already existing laser beams. But it will be destroyed on the first additional beam and on laser beams that are switched off and on again.

If another item transforms into an umbrella this new umbrella will be immune to light destruction for a short latency period to avoid repeated item transformations.

Attributes:

freezable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.2 [freezable], page 183
liftable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.3 [liftable], page 184
portable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.4 [portable], page 184

Variants:

it_umbrella A standard umbrella item.

it_umbrella_new An umbrella that is immune to light destruction for a short latency period.

8.3.33 it_weight

A weight is an item with a mass, that defaults to the mass of 10 Section 10.2.4 [ac_marble], page 325s. When it is picked up it is added to the inventory and increases the mass of all actors owned by the inventory's owner.

Weights can easily be picked up, but the player can not drop them. Just indirect methods like hitting Section 9.5.40 [st_mail], page 277, Section 9.5.65 [st_thief], page 308, or crossing a Section 7.4.12 [fl_thief], page 178, may remove this item from the inventory.

The inventories mass is always updated to the mass of all weights kept in the inventory or contained in any Section 8.3.1 [it_bag], page 184, contained in the inventory.

Attributes: none

mass *values*: positive float number; *default*: `+10.0`
Mass unit is the mass of an Section 10.2.4 [ac_marble], page 325,

freezable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.2 [freezable], page 183
liftable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.3 [liftable], page 184
portable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.4 [portable], page 184

Messages: none
Variants:

it_weight

8.3.34 it_wrench

A wrench wielded as first item in the players inventory causes some objects to react on actor hits. An Section 9.5.56 [st_rotator], page 298, changes its turning direction. A green Section 9.5.67 [st_turnstile], page 309, rotates backwards when hit. An Section 9.5.70 [st_window], page 313, face pushed with a wrench will swap to the opposite side of the stone if possible.

Attributes:

freezable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.2 [freezable], page 183
liftable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.3 [liftable], page 184
portable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.4 [portable], page 184

Messages: none
Variants:

it_wrench

8.3.35 it_yinyang

A special switch that allows the user to toggle the Section 4.1.5 [Player and Inventory], page 48, between `YIN` and `YANG`.

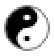
On activation this item does not get dropped but remains unchanged in the inventory.

If a level has been declared to be a full blown two player network level in Section 3.3.7 [<modes>], page 35, but is currently played on a single computer both players get automatically an yinyang item added to their inventory to allow all actors to be controlled at every point of time.

Attributes:

> **freezable**, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.2 [freezable], page 183
> **liftable**, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.3 [liftable], page 184
> **portable**, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.4 [portable], page 184

Messages: none
Variants:



it_yinyang

8.4 Static Items

8.4.1 it_blocker

A door like object that grows to Section 9.5.4 [st_blocker], page 244, when an Section 9.5.6 [st_boulder], page 246, passes. When the boulder did shrink and pass the blocker again it stays in its item like open state until it is passed again by a boulder which causes it to grow again to a blocker stone.

It fully supports the messages of any door like object and can be opened and closed by any switch like object. Note that due to the transformation between stone and item during opening and closing you should name the blocker (see Section 6.1.1 [name], page 125) and address the blocker by this name. The complete identity with all attributes including any user attributes will be transferred between stone and item. E.g. `{it_switch, target="myblocker", action="toggle"}` will open and close a given blocker multiple times.

Note that the blocker is the only door object that allows a stone to be pushed through. Just boulders cause the growing. Any other stone keeps the open state.

Another unique door feature is the closing of a blocker item caused by a passing actor if the autoclose attribute is set to true.

Note that a dropped Section 8.3.4 [it_brake], page 187, destroys this item.

Attributes:

state, *values*: `0`, `1`; *default*: `1` See Section 6.1.2 [state], page 125
: Use CLOSED and OPEN macros as values. The item represents the open state and will always return state 1. But you can set its state what is equivalent to sending an open message in case of value 1 and a close message in case of value 0.

autoclose *values*: `true`, `false`; *default*: `false`
: A true value causes any actor passing this item to close and grow the blocker.

freezable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.2 [freezable], page 183
liftable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.3 [liftable], page 184
portable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.4 [portable], page 184

Messages:

signal See Section 6.2.3 [signal], page 130
: A signal of value 1 sends an open message, a signal of value 0 sends a close message.

toggle See Section 6.2.1 [toggle], page 129
: A toggle causes a close message.

close See Section 6.2.7 [close], page 131
: A close message takes immediate effect if the item is not covered by a stone. The item transforms to a new growing Section 9.5.4 [st_blocker], page 244. If it is covered by a stone of whatever kind it will be marked as unlocked. The closing process starts when the stone moves away.

open See Section 6.2.6 [open], page 130
: As the item is open this message takes only effect if it is currently covered by a stone and marked as unlocked. That means it should grow as soon as the stone moves away what happens when an Section 9.5.6 [st_boulder], page 246, passes an idle blocker item. In this case an open message locks the blocker again to avoid a growing when the stone moves away.

Action: See Section 6.1.3 [target], page 126, See Section 6.1.4 [action], page 126
Sends an action at the moment the blocker reaches the open state. That means an Section 9.5.4 [st_blocker], page 244, did open and did generate this blocker item as its successor. The value will be `true` to express the open state.

Variants:

it_blocker
: A standard blocker item.

it_blocker_new

A blocker that just finished shrinking. Mainly used internally as the direct successor of an Section 9.5.4 [st_blocker], page 244. But it may be useful to generate an initial snapshot of a moving boulder over a blocker line, too. See example levels.

8.4.2 it_bomb

A bomb is an explosive that can not be picked up. It ignites on laser light, nearby fire and other nearby explosions as those caused by other Section 8.4.2 [it_bomb], page 211s, Section 8.3.11 [it_dynamite], page 192, Section 9.5.18 [st_dispenser], page 257, exploding directly above a bomb, or simply by a solid stone being pushed over them (just a few stones like Section 9.5.59 [st_shogun], page 300, Section 9.5.7 [st_box], page 248_hay do not cause bombs to ignite). A falling Section 11.1.1 [ot_cannonball], page 330, lets it explode immediately without prior ignition.

On ignition its fuse starts burning. After a short time the bomb explodes causing on the 8 neighboring positions items to ignite and some stones like Section 9.5.9 [st_break], page 250, to dissolve, too. An already burning floor however might get extinguished by a neighboring bomb explosion.

'`BLACK`' bombs will cause destructible items on the 4 neighboring positions to be blown away, and dissolve the floor beneath to a Section 7.4.1 [fl_abyss], page 166.

'`WHITE`' bombs will cause destructible items on the 8 neighboring positions to be blown away, and dissolve the floor beneath and the 8 neighboring positions to Section 7.4.1 [fl_abyss], page 166.

Bomb items will be added to the inventory when an actor hits a Section 9.5.18 [st_dispenser], page 257_bombblack or Section 9.5.18 [st_dispenser], page 257_bombwhite.

Attributes:

state, *values*: `IDLE`, `ACTIVE`; *default*: `IDLE` See Section 6.1.2 [state], page 125
color *values*: `BLACK`, `WHITE`; *default*: `BLACK`
freezable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.2 [freezable], page 183
liftable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.3 [liftable], page 184
portable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.4 [portable], page 184

Just bombs in '`state`' '`IDLE`' are portable, burning '`ACTIVE`' ones can not be added to the inventory or an Section 8.3.1 [it_bag], page 184.

Messages:

explode Direct explosion without burning fuse.

ignite Ignite the fuse.

heat Ignite the fuse.

Variants:

it_bomb: color = `BLACK`

it_bomb_black: color = `BLACK`

it_bomb_white: color = `WHITE`

8.4.3 it_burnable

A legacy item representing the fire state and handling the visible animation. This item is nowadays mainly an internal system item as the Section 13.2.3 [Fire Spreading], page 392, with its attributes and messages is mainly handled by the Chapter 7 [Floor Objects], page 148. But it may be essential for your understanding to be aware of this object in all its variants. You may also need to make use of all variants on level initialization due to the Section 4.4.2 [Snapshot Principle], page 58.

The following variants do exist:

- '`invisible`' - allow a floor tile to catch fire, and to ignite on explosions; set the attributes Section 7.2.2 [burnable], page 149, and Section 7.2.12 [ignitable], page 151, on the floor instead.
- '`oil`' - is the visible variant of the invisible burnable item.
- '`ignited`' - carries the starting-animation of fire; send the '`setfire`' message to a floor or set the floor with attribute '`initfire`' instead.
- '`burning`' - carries the animation of burning fire. Use setfire instead.
- '`ash`' - the unburnable remnant of a fire.
- '`fireproof`' - the extinguisher foam that protects from fire.

Note that you are not allowed to set or change the '`state`' of a burnable item. But you can investigate the kind of a burnable.

Besides by Section 13.2.3 [Fire Spreading], page 392, the user can interact with burnable items with the following other objects:

- Section 8.3.12 [it_extinguisher], page 192, sprays '`fireproof`' foam
- Section 8.3.5 [it_brush], page 188, removes '`ash`' and '`fireproof`'
- Section 9.5.29 [st_ice], page 267, removes all burnable besides '`oil`' when being pushed over them

Attributes:

state, *values*: integer numbers between 0 and 5; *default*: `0`; *access*: `read only` See Section 6.1.2 [state], page 125
freezable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.2 [freezable], page 183
liftable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.3 [liftable], page 184
portable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.4 [portable], page 184

Messages:

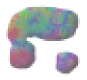
ignite See Section 6.2.8 [ignite], page 131
Ignites the floor beneath.

extinguish Changes burnable immediately to extinguisher foam.

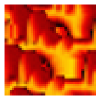
Variants:

it_burnable: state = `0`

it_burnable_invisible: state = `0`


it_burnable_oil: state = `1`

it_burnable_ignited: state = `2`


it_burnable_burning: state = `3`

it_burnable_ash: state = `4`

it_burnable_fireproof: state = `5`

8.4.4 it_crack

A legacy item that features a crack in the floor. A crack increases every time an actor enters and finally dissolves the floor either into an Section 7.4.1 [fl_abyss], page 166, or an Section 7.4.13 [fl_water], page 178. The color of the fissures shows the upcoming new floor kind and corresponds to the attribute '`flavor`'.

The progress of the floor destruction is described by the attribute '`state`'. On every crack event the state advances by one and a cracking '`LARGE`' crack finally dissolves giving an actor on top just enough time to leave the grid at once. Of course an actor jumping over a crack does not causes change on the crack itself.

You can control the crack progress by the two attributes '`spreading`' and '`fragility`'. Where as the first attribute describes the likelihood that the crack spreads to a neighboring crack free grid, does the second attribute describe the likelihood that an existing crack advances its state.

An actor entering a crack causes the crack itself to advance its state with the given likelihood. A default '`abyss`' crack causes existing cracks on any of the 4 neighboring grid positions to advance their states, too. But a '`water`' crack does not advance neighboring cracks. Both do cause a spread with the given likelihood of an invisible crack to any of the 4 neighboring grid positions in case no crack or any other items exists on it.

Let us have another look on a spreading crack. An actor entering a crack causes an invisible crack on the next grid. If the actor continues to move to this grid the invisible crack advances to a small visible one, of course just with the given likelihood. Note that this first and just this first crack progress takes place with the likelihood of spreading, too. That means even if the fragility is zero the invisible crack gets visible.

Another special feature is the behaviour of a large crack. An actor entering causes it to dissolve. But this causes neither a spreading nor a crack advancing on neighboring grids. This feature is essential to allow an actor to walk over a path of large cracks, as the next grid may not dissolve on an actor entering the one before.

Common attribute patterns besides the default ones are:

- '`spreading=0, fragility=0`' - a fake crack that neither spreads nor dissolves
- '`spreading=0, fragility=1`' - a crack that dissolves and causes neighbor cracks to dissolve, but does not spread to new floors

Both attributes are inherited to new cracks during the process of spreading. If not set they take as default the value of the global attributes. For a maximum control you can set individual floors their own Section 7.2.9 [fragility (floor)], page 151. These values supersede the global Section 6.4.15 [Fragility], page 141, default.

Indestructible floors like Section 7.4.1 [fl_abyss], page 166, Section 7.4.13 [fl_water], page 178, Section 7.4.11 [fl_swamp], page 177, will never crack. As any other item cracks do block laser light and prohibit other items to be dropped on the same grid. Nearby fire, explosions and hitting Section 11.1.1 [ot_cannonball], page 330s will dissolve a crack by another step.

On the other hand Section 9.5.29 [st_ice], page 267, will putty any existing crack when being pushed over it.

Attributes:

state, *values*: `INVISIBLE`, `SMALL`, `MEDIUM`, `LARGE`; *default*: `SMALL` See Section 6.1.2 [state], page 125
flavor, *values*: `"abyss"`, `"water"`; *default*: `"abyss"`
spreading *values*: positive number between 0.0 and 1.0; *default*: `0.5`, See Section 6.4.6 [CrackSpreading], page 139
fragility *values*: positive number between 0.0 and 1.0; *default*: `1.0`, See Section 6.4.15 [Fragility], page 141
freezable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.2 [freezable], page 183
liftable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.3 [liftable], page 184
portable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.4 [portable], page 184

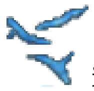
Messages:

crack

toggle See Section 6.2.1 [toggle], page 129
ignite See Section 6.2.8 [ignite], page 131
heat See Section 6.2.9 [heat], page 131

Variants:

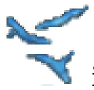
it_crack: state = `SMALL`, flavor = `"abyss"`


it_crack: state = `SMALL`, flavor = `"water"`

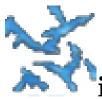
it_crack_i: state = `INVISIBLE`, flavor = `"abyss"`

it_crack_i: state = `INVISIBLE`, flavor = `"water"`

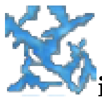
it_crack_s: state = `SMALL`, flavor = `"abyss"`


it_crack_s: state = `SMALL`, flavor = `"water"`

it_crack_m: state = `MEDIUM`, flavor = `"abyss"`


it_crack_m: state = `MEDIUM`, flavor = `"water"`

it_crack_l: state = `LARGE`, flavor = `"abyss"`


it_crack_l: state = `LARGE`, flavor = `"water"`

8.4.5 it_cross

An eye-catching cross spot that can detect actors staying on it for a given time. When an actor remains on top of the cross for the given '`interval`' without any other actor leaving or passing the cross grid the cross will perform its action. Similar, but instant sensors for actors are Section 8.4.12 [it_sensor], page 221, and Section 8.4.18 [it_trigger], page 226, A cross can be drawn with an Section 8.3.20 [it_pencil], page 198, and it can be removed with an Section 8.3.5 [it_brush], page 188.

An Section 9.5.38 [st_lightpassenger], page 275, moving onto a cross item will switch off.

Attributes:

state, *values*: `0`, `1`; *access*: `read only` See Section 6.1.2 [state], page 125
: The current state - '`0`' for the last event being an actor leaving the cross, '`1`' for the last event being an actor entering the cross.

interval *values*: positive number; *default*: `10.0`
: Number of seconds that the actor must stay on the sensor to cause an action.

freezable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.2 [freezable], page 183
liftable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.3 [liftable], page 184
portable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.4 [portable], page 184

Messages: none
Action: See Section 6.1.3 [target], page 126, See Section 6.1.4 [action], page 126
Variants:

it_cross

8.4.6 it_death

This item shatters any marble that tries to pass the grid. Even jumping marbles will be shattered. Just marbles protected by an activated Section 8.3.32 [it_umbrella], page 207, can pass without taking harm. Apart from that an '`it_death`' barrier can only be passed by walking around the complete barrier or by warping through an Section 8.4.19 [it_vortex], page 227, an Section 8.4.20 [it_wormhole], page 229, or by means of an Section 8.3.24 [it_ring], page 201.

The death item is the most secure barrier object. Comparable objects are Section 8.3.3 [it_bottle], page 186_broken, Section 7.4.1 [fl_abyss], page 166, Section 7.4.13 [fl_water], page 178, Section 8.4.17 [it_trap], page 226, or simply any solid wall of stones. Usually these alternatives should be favored. The death item should mainly be used when all other alternatives are too insecure.

Attributes:

freezable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.2 [freezable], page 183
liftable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.3 [liftable], page 184
portable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.4 [portable], page 184

Messages: none
Variants:

it_death

8.4.7 it_explosion

An intermediate short living system item representing and visualizing an explosion. There are very few acceptable usages of this item besides the internal setting due to explosions of Section 8.4.2 [it_bomb], page 211, Section 8.3.11 [it_dynamite], page 192, Section 8.4.8 [it_landmine], page 217, and Section 11.1.1 [ot_cannonball], page 330.

All explosions do shatter ball like actors.

The following variants do exist:

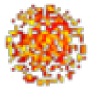
- '`nil`' - no remnants.
- '`hollow`' - leave an Section 8.4.11 [it_meditation], page 219_hollow.
- '`crack`' - make an Section 8.4.4 [it_crack], page 213_water.
- '`debris`' - dissolve the floor to Section 6.4.31 [SubSoil], page 145, which defaults to Section 7.4.1 [fl_abyss], page 166,

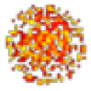
Note that you are not allowed to set or change the '`state`' of an explosion item. But you can investigate the kind of an explosion.

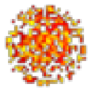
Attributes:

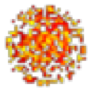
state, *values*: integer numbers between 0 and 3; *default*: `0`; *access*: `read only` See Section 6.1.2 [state], page 125
freezable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.2 [freezable], page 183
liftable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.3 [liftable], page 184
portable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.4 [portable], page 184

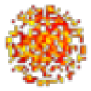
Messages: none
Variants:


it_explosion: state = `0`


it_explosion_nil: state = `0`


it_explosion_hollow: state = `1`


it_explosion_crack: state = `2`


it_explosion_debris: state = `3`

8.4.8 it_landmine

A static item that explodes on actors stepping onto its critical center part and on stones being pushed onto the mine.

The landmine explodes shattering nearby marbles on the same grid and leaves an hollow Section 8.4.11 [it_meditation], page 219, behind.

Actors can jump over a landmine and pass carefully between two adjacent landmines without activating the mines. Landmines do neither react on nearby explosions, nor fire, nor laserbeams.

Attributes:

freezable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.2 [freezable], page 183
liftable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.3 [liftable], page 184
portable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.4 [portable], page 184

Messages: none
Action: none
Variants:

it_landmine

8.4.9 it_laserbeam

A beam of laser light. This item is caused by an Section 9.5.34 [st_laser], page 272, that is switched on. The beam is automatically calculated and the items are set by the engine. You can not set laser beam items on your own. But you may detect a beam as an item being located on the item layer. You are free to replace a laser beam item by another item. This causes automatically a recalculation of the laser light.

Attributes:

freezable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.2 [freezable], page 183
liftable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.3 [liftable], page 184
portable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.4 [portable], page 184

Messages: none
Variants:

it_laserbeam can not be instantiated by levels

8.4.10 it_magnet

Attracts or repels actors in its '`range`' with a force proportional to the '`strength`' and the inverse of the squared distance. A magnet can be switched '`ON`' and '`OFF`'.

Note that no forces are applied to actors at a distance smaller than 0.05 grids to avoid extraordinary large forces.

Attributes:

state, *values*: `ON`, `OFF`; *default*: `OFF` See Section 6.1.2 [state], page 125
: The current magnet state - '`ON`' for an active magnet, '`OFF`' for an inactive magnet.

range *values*: float number greater or equal 0; *default*: `10.0` See Section 6.4.21 [MagnetRange], page 143
: The distance up to which the magnet applies forces to actors.

strength *values*: float number; *default*: `+30.0` See Section 6.4.22 [MagnetStrength], page 143
: A scalar factor for magnet forces. Positive numbers are attracting forces where as negative numbers are repelling forces.

freezable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.2 [freezable], page 183
liftable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.3 [liftable], page 184
portable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.4 [portable], page 184

Messages:

signal See Section 6.2.3 [signal], page 130
: A signal of value 1 switches the magnet on, a value of 0 switches the magnet off.

toggle See Section 6.2.1 [toggle], page 129
: A toggle causes a change in the magnet activity state.

on See Section 6.2.4 [on], page 130
: Switches the magnet on.

off See Section 6.2.5 [off], page 130
: Switches the magnet off.

Action: none

Variants:

it_magnet state = '`OFF`'.

it_magnet_on state = '`ON`'.

it_magnet_off state = '`OFF`'.

8.4.11 it_meditation

Meditation items are small round areas of flatness imperfection. All actors will experience the slope forces that can be modified by the global scalar factor Section 6.4.24 [MeditationStrength], page 143. There are different shapes of meditation items that are named according to their shape: `MEDITATION_CALDERA`, `MEDITATION_HOLLOW`, `MEDITATION_DENT`, `MEDITATION_BUMP`, `MEDITATION_HILL`, `MEDITATION_VOLCANO`.

Of special interest are Section 10.2.5 [ac_pearl], page 326s resting on a meditation item. They are counted as meditating after staying continuously for one second within the round area of the item. One of the two Section 4.4.8 [Ending Conditions], page 61, of the game is that all meditation marbles come to rest on mediation items.

As meditation items can dynamically be generated during the game by exploding Section 8.4.8 [it_landmine], page 217, or Section 8.3.11 [it_dynamite], page 192, it may be necessary for an author to mark those meditation items that are required to be filled with meditation marbles. You do this by setting the '`essential`' attribute to `true`. Please make rare and obvious usage of this attribute, as the player can not distinguish essential from not essential meditation items by their images.

Meditation items can transform into other shapes by various means.

First a user can push a solid stone over a meditation item or activate an Section 8.3.27 [it_spade], page 204, on it. Both actions flatten the meditation, either `MEDITATION_VOLCANO -> MEDITATION_HILL -> MEDITATION_BUMP -> it_nil` or `MEDITATION_CALDERA -> MEDITATION_HOLLOW -> MEDITATION_DENT -> it_nil`.

Secondly you can send a `"flip"` message to a meditation item which transforms hollow like items into their hill like counterparts and vice versa: `MEDITATION_VOLCANO <-> MEDITATION_CALDERA`, `MEDITATION_HILL <-> MEDITATION_HOLLOW`, `MEDITATION_BUMP <-> MEDITATION_DENT`.

Third a `"signal"` message flips on a `1` value all meditations to their hill like counterparts, keeping hill like meditations unchanged, and on a `0` value to their hollow like counterparts, keeping hollow like meditations unchanged.

A fourth message is `"toggle"`. It transforms `MEDITATION_HOLLOW <-> MEDITATION_VOLCANO`, `MEDITATION_CALDERA <-> MEDITATION_HILL`, `MEDITATION_BUMP <-> MEDITATION_DENT`.

Of course you can change the state by setting the attribute anytime in any sequence you like. Essentialness is kept on shape transformations and mediation actor counting is updated and continues.

Attributes:

state, *values*: `MEDITATION_CALDERA`, `MEDITATION_HOLLOW`, `MEDITATION_DENT`, `MEDITATION_BUMP`, `MEDITATION_HILL`, `MEDITATION_VOLCANO`; *default*: `MEDITATION_HOLLOW` See Section 6.1.2 [state], page 125

The shape of the meditation.

essential *values*: `DISPENSABLE`, `INDISPENSABLE`; *default*: `DISPENSABLE`

Essentialness of being filled with a meditation marble to fulfill the Section 4.4.8 [Ending Conditions], page 61.

friction, *values*: number; *default*: `nil` See Section 6.1.9 [friction], page 128

Deviating friction that defaults to floor friction.

adhesion, *values*: number; *default*: `nil` See Section 6.1.10 [adhesion], page 128

Deviating adhesion that defaults to floor adhesion.

freezable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.2 [freezable], page 183
liftable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.3 [liftable], page 184
portable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.4 [portable], page 184

Messages:

flip Shape transformation. See text above.

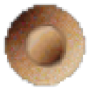
shovel Shape transformation like an activated Section 8.3.27 [it_spade], page 204. See text above.

signal See Section 6.2.3 [signal], page 130
Shape transformation. See text above.

toggle Shape transformation. See text above.

Variants:

it_meditation state = `MEDITATION_HOLLOW`


it_meditation_caldera state = `MEDITATION_CALDERA`

it_meditation_hollow state = `MEDITATION_HOLLOW`

it_meditation_dent state = `MEDITATION_DENT`

it_meditation_bump state = `MEDITATION_BUMP`

it_meditation_hill state = `MEDITATION_HILL`

it_meditation_volcano state = `MEDITATION_VOLCANO`

8.4.12 it_sensor

The sensor item is a switch on top of a floor that reacts on actors passing it. It performs actions on actors either entering or exiting the sensor's grid depending on its attribute '`exit`'. It will send the causing actor as action value, which evaluates like '`true`' in Lua, but nevertheless the Section 6.1.7 [inverse], page 127, attribute can be used to send an action value of '`false`' instead.

Any actors passing the grid, either on the floor or jumping over it will be detected.

Sensors do not cause any noise. Visible sensors will nevertheless flash on passing actors. You can make the trigger invisible by setting its attribute. Be aware that the user will still notice that actors cannot drop items onto the same grid position.

The level author can configure Section 8.3.16 [it_glasses], page 195, by addition of 'SPOT_SENSOR' to show invisible sensor items. An actor with such an Section 8.3.16 [it_glasses], page 195, in its inventory will be able to spot invisible sensor items. With the global attribute Section 6.4.9 [ExtralifeGlasses], page 140, even glasses generated by laser lighting an Section 8.3.13 [it_extralife], page 193, can be configured not to show invisible sensor items.

Alternative objects that react on actors are Section 8.4.18 [it_trigger], page 226, and Section 8.4.5 [it_cross], page 215.

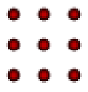
Attributes:

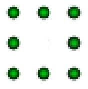
invisible *values*: `true`, `false`; *default*: `false`
An invisible sensor is totally transparent. But the user may notice it, as actors cannot drop items onto the same grid position.

exit *values*: `true`, `false`; *default*: `false`
React either on an actor exiting or entering the grid.

freezable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.2 [freezable], page 183
liftable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.3 [liftable], page 184
portable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.4 [portable], page 184

Messages: none
Action: See Section 6.1.3 [target], page 126, See Section 6.1.4 [action], page 126
Variants:

 **it_sensor**: exit = `false`

 **it_sensor_exit**: exit = `true`

8.4.13 it_shogun

A dot like, blue animated sensor item for Section 9.5.59 [st_shogun], page 300, stones. The dot comes in three variations matching the different hole sizes of shogun stones.

Shogun dots detect stacks of Section 9.5.59 [st_shogun], page 300, that contain all variations from small up to the size of the dot. Thus the small dot requires just a single small shogun stone, the middle sized dot requires a stack of a small shogun beneath a middle sized shogun stone, whereas the large dot requires a stack of all three shogun stones on top.

There is no way to set the state of a dot manually. But the state can nevertheless be read. At initialization a dot with a matching shogun stack on top will start in state 'ON' without sending actions due to the Section 4.4.2 [Snapshot Principle], page 58.

Note that a dot is freezable by an Section 9.5.29 [st_ice], page 267, and can thus be relocated to another position.

Attributes:

state, *values*: `OFF`, `ON`; *default*: `OFF`; *access*: `read only` See Section 6.1.2 [state], page 125
The current state of the dot - ‘`ON`’ for a matching Section 9.5.59 [st_shogun], page 300, stack on top, ‘`OFF`’ otherwise.

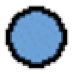
flavor, *values*: `"s"`, `"m"`, `"l"`; *default*: `"s"`
A string describing the hole size. `"s"` for a small hole, `"m"` for a medium hole, `"l"` for a large hole.

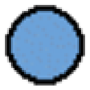
freezable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.2 [freezable], page 183
liftable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.3 [liftable], page 184
portable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.4 [portable], page 184

Messages: none
Action: See Section 6.1.3 [target], page 126, See Section 6.1.4 [action], page 126
Variants:

it_shogun: flavor = `"s"`

it_shogun_s: flavor = `"s"`


it_shogun_m: flavor = `"m"`


it_shogun_l: flavor = `"l"`

8.4.14 it_springboard

A static jump facility that lets Section 10.3.1 [Flying Actors], page 329, jump on passing its center square. A springboard can catapult any number of actors anytime with an idle reloading time after an activation.

A springboard positioned on top of a floor can not be picked up. But nevertheless as being portable, it can be added to the initial inventory, to an Section 8.3.1 [it_bag], page 184, or can be picked up as a result of a Section 8.3.30 [it_surprise], page 205.

Another catapulting, but liftable item is Section 8.3.29 [it_spring], page 205.

Attributes:

freezable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.2 [freezable], page 183
liftable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.3 [liftable], page 184
portable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.4 [portable], page 184

Messages: none
Variants:

it_springboard

8.4.15 it_squashed

The remnants of fruits like Section 8.3.6 [it_cherry], page 188, and Section 8.3.2 [it_banana], page 185, after pushing a stone over it.

The squashed remnants are scarcely visible on some floor types. The player can not pick them up. But it can be wiped away by application of an Section 8.3.5 [it_brush], page 188, by a nearby exploding Section 8.4.2 [it_bomb], page 211, or by an Section 9.5.29 [st_ice], page 267, being pushed over it.

Attributes:

freezable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.2 [freezable], page 183
liftable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.3 [liftable], page 184
portable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.4 [portable], page 184

Messages: none
Variants:

it_squashed

8.4.16 it_strip

These items cover a small strip of the ground below them and provide a narrow bridge for the marble to safely pass Section 7.4.1 [fl_abyss], page 166, Section 7.4.11 [fl_swamp], page 177, Section 7.4.13 [fl_water], page 178, or any other floor.

A strip connects zero, what is just a central small unconnected square, or up to 4 neighboring floor grids. A marble can pass from one connected floor to another connected floor via the strip.

Any stone on a directly neighboring grid can be touched or hit by a large marble and prevents it from falling off the strip on this side. Small marbles can not touch neighboring stones and will not be protected from falling.

Per default an actor on a covering strip is exposed to the same friction and adhesion as on the floor below. But strips can provide its own deviating values for these factors.

Attributes:

connections, *values*: string; *default*: `nil`
: Describes the connections to the neighbor grids. The string is a substring of `"nesw"` listing the existing connections. The sequence of the sides, north, east, south, west, is guaranteed on read access but arbitrary on write access.

friction, *values*: number; *default*: `nil` See Section 6.1.9 [friction], page 128
: Deviating friction that defaults to floor friction.

adhesion, *values*: number; *default*: `nil` See Section 6.1.10 [adhesion], page 128
: Deviating adhesion that defaults to floor adhesion.

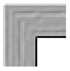
freezable, *values*: `true`, `false`; *default*: `true`; *access*: `read only` See Section 8.2.2 [freezable], page 183
liftable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.3 [liftable], page 184
portable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.4 [portable], page 184

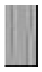
Variants:

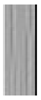
it_strip: connections = `""`

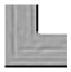
it_strip_s: connections = `"s"`

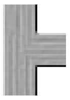
it_strip_e: connections = `"e"`


it_strip_es: connections = `"es"`

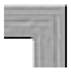

it_strip_n: connections = `"n"`


it_strip_ns: connections = `"ns"`

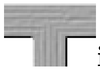

it_strip_ne: connections = `"ne"`

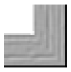

it_strip_nes: connections = `"nes"`

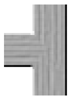
it_strip_w: connections = `"w"`

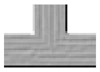

it_strip_sw: connections = `"sw"`

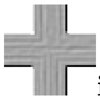
it_strip_ew: connections = `"ew"`


it_strip_esw: connections = `"esw"`


it_strip_nw: connections = `"nw"`


it_strip_nsw: connections = `"nsw"`


it_strip_new: connections = `"new"`


it_strip_nesw: connections = `"nesw"`

8.4.17 it_trap

A classical trap that is camouflaged by a floor image. Any marble stepping onto this trap will break the trap and fall into the trap's abyss. But marbles can jump unharmed over a trap. Movable stones can be pushed over a trap without any reaction.

Any marble falling into a trap causes it to break and to become visible by the remnants of the trap. The trap can be opened by messages, too.

The level author can configure Section 8.3.16 [it_glasses], page 195, by addition of '`SPOT_TRAP`' to show invisible traps. An actor with such an Section 8.3.16 [it_glasses], page 195, in its inventory will be able to spot invisible traps. With the global attribute Section 6.4.9 [ExtralifeGlasses], page 140, even glasses generated by laser lighting an Section 8.3.13 [it_extralife], page 193, can be configured to show invisible traps.

Attributes:

state, *values*: `CLOSED`, `OPEN`; *default*: `CLOSED` See Section 6.1.2 [state], page 125

A '`CLOSED`' trap is intact and invisible, an '`OPEN`' trap is broken and visible.

freezable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.2 [freezable], page 183
liftable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.3 [liftable], page 184
portable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.4 [portable], page 184

Messages:

signal See Section 6.2.3 [signal], page 130

Opens the trap on value '`1`'

toggle See Section 6.2.1 [toggle], page 129

Opens the trap.

open See Section 6.2.6 [open], page 130

Opens the trap.

Variants:

it_trap

8.4.18 it_trigger

The trigger item is a switch on top of a floor that reacts on actors and stones on top of it that may press it. It performs actions when it is initially pressed and again when it releases after the last object left it. A pressed trigger is in state '`ON`' and will send an action value of '`true`', a released trigger is in state '`OFF`' and will send an action value of '`false`'.

Only actors moving on the floor will press triggers. An actor jumping over a trigger will not press it. An actor jumping on a trigger will release and press it again.

Just solid stones will press the trigger when pushed onto it. Floating, hollow stones will generally not press the trigger with the exception of the hollow, central puzzle stone (see Section 9.5.52 [st_puzzle], page 292).

There is no way to set the state of a trigger manually. But the state can nevertheless be read. At initialization a trigger that is pressed by objects will start in state '`ON`' without sending actions due to the Section 4.4.2 [Snapshot Principle], page 58.

You can make the trigger invisible by setting its attribute. Be aware that it still produces its click-sounds and the user will notice that actors cannot drop items onto the same grid position.

Alternative items that react just on actors are Section 8.4.12 [it_sensor], page 221, and Section 8.4.5 [it_cross], page 215. Another switch that reacts on the actor's mass and stones are the Section 7.4.9 [fl_scales], page 174.

Attributes:

state, *values*: `ON`, `OFF`; *access*: `read only` See Section 6.1.2 [state], page 125

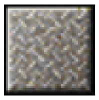
The current switch state - '`ON`' for a pressed trigger, '`OFF`' for a released trigger.

invisible *values*: `true`, `false`; *default*: `false`

An invisible trigger is totally transparent. But the user may notice it, as actors cannot drop items onto the same grid position.

freezable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.2 [freezable], page 183
liftable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.3 [liftable], page 184
portable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.4 [portable], page 184

Messages: none
Action: See Section 6.1.3 [target], page 126, See Section 6.1.4 [action], page 126
Variants:


it_trigger

8.4.19 it_vortex

Teleports Section 10.2.4 [ac_marble], page 325, and Section 10.2.5 [ac_pearl], page 326, to a given '`destination`'. Unlike Section 8.4.20 [it_wormhole], page 229, it does not teleport other Section 10.2 [Actors], page 322.

In the simplest case, a vortex is connected to a single destination given by an object or a position. If the destination is not blocked by a stone the actor will be teleported to the destination.

If multiple destination addresses are given, the actor will be teleported to the single destinations in sequence. Blocked destinations are indicated by sparkles. Finally the actor exists on the first unblocked destination. If no unblocked destination exists the marble exists at the starting vortex. A level author can write nice puzzle which require the user to block destinations to reach the final destination of a vortex.

Vortices can be '`OPEN`' or '`CLOSED`'. Of course an actor can enter just an open vortex. Closed vortices at the destination are opened automatically. By default such vortices remain open. By usage of the attribute '`autoclose`' you can configure a vortex to close after an actor has been emitted. This helps the user to leave the vortex by keeping the marble from being reinserted into the vortex. Of course an autoclose disables the user to return, too. If this is not your intention you set additionally the attribute '`autoopen`' to `true`. The vortex will reopen again when the marble leaves the closed vortex. If the user did directly jump out of the vortex, it will reopen when the user enters the vortex grid again.

Actors are emitted by vortices in a jumping fashion. The user can accelerate the actor for a short period and the actor may jump out of a vortex into the desired direction.

Vortex teleportation takes a short amount of time and the involved vortices are blocked for other teleporting request during this process. Thus it is no problem to set up destinations of vortices that build a cycle.

Rubberbands bound to teleported actors are cut by default. The attribute '`scissor`' allows you to control the cutting behaviour.

But the teleporting feature of a vortex is not limited to actors. A water flood will spread through a vortex, too. In contrast to actors the flood will spread to all destinations at the same time. Of course a closed vortex on either side of the teleportation will block a flood from spreading. But the flood continues as soon as the vortices are opened again. Destinations will not be blocked by stones for a flood penetrating the grid from beneath, but may block the water from spreading further from the destination grid positions. All important details are explained in section Section 13.2.2 [Flood Spreading], page 390.

Attributes:

state, *values*: `OPEN`, `CLOSED`; *default*: `OPEN` See Section 6.1.2 [state], page 125
: The visual state of a vortex. An '`OPEN`' vortex may still be busy due to ongoing teleportations and may not accept a marble.

destination, *values*: tokens or position; *default*: `nil` See Section 6.1.8 [destination], page 127
: The destination of the teleport given by an object or a position.

autoclose, *values*: `true`, `false`; *default*: `false`
: Flag that indicates whether the vortex should be closed after a teleport.

autoopen, *values*: `true`, `false`; *default*: `false`
: Flag that indicates whether the vortex should open when an actor enters the grid or leaves the vortex.

scissor, *values*: `true`, `false`; *default*: `true`
: Rubberband cutting behaviour on teleporting.

freezable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.2 [freezable], page 183
liftable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.3 [liftable], page 184
portable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.4 [portable], page 184

Messages:

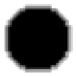
signal See Section 6.2.3 [signal], page 130
: Opens the vortex on value '`1`', and closes the vortex on value '`0`'.

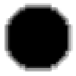
toggle See Section 6.2.1 [toggle], page 129
: Opens a closed vortex and closes an open vortex if possible.

open See Section 6.2.6 [open], page 130
: Tries to open the vortex.

close See Section 6.2.7 [close], page 131
: Tries to close the vortex.

Action: none
Variants:


it_vortex: state = `OPEN`.


it_vortex_open: state = `OPEN`.

it_vortex_closed: state '`CLOSED`'.

8.4.20 it_wormhole

Teleports Section 10.2 [Actors], page 322, of any kind to a given '`destination`'. Unlike Section 8.4.19 [it_vortex], page 227, every wormhole has a unique destination. But of course the destination may be another wormhole which instantly teleports the actor again. An infinite circle of wormholes that are connected by destinations is forbidden.

A wormhole can attract or repel actors in its '`range`' with a force proportional to the '`strength`' and the inverse of the squared distance. The force can be switched '`ON`' and '`OFF`' and is represented by its external '`state`'. Note that no forces are applied to actors at a distance smaller than 0.05 grids to avoid extraordinary large forces.

Rubberbands bound to teleported actors are cut by default. The attribute '`scissor`' allows you to control the cutting behaviour.

After teleporting an actor, the wormhole's teleporting ability may be switched off for a short latency period given by '`interval`'. A latency separates actors traveling through a wormhole and avoids overlapping actors at the destination.

But the teleporting feature of a wormhole is not limited to actors. A water flood will spread through a wormhole, too. Of course all actor related attributes described above have no influence on the flood. Just the '`destination`' is important as explained in details in Section 13.2.2 [Flood Spreading], page 390.

Attributes:

state, *values*: `ON`, `OFF`; *default*: `ON` See Section 6.1.2 [state], page 125
: The current force state - '`ON`' for a force applying wormholes, '`OFF`' for force neutral wormholes.

destination, *values*: tokens or position; *default*: `nil` See Section 6.1.8 [destination], page 127
: The destination of the teleport given by an object or a position.

range *values*: float number greater or equal 0; *default*: `10.0` See Section 6.4.36 [WormholeRange], page 146

The distance up to which the wormhole applies forces to actors.

strength *values*: float number; *default*: `+30.0` See Section 6.4.37 [WormholeStrength], page 146

A scalar factor for the wormhole force. Positive numbers are attracting forces where as negative numbers are repelling forces.

scissor, *values*: `true`, `false`; *default*: `true`

Rubberband cutting behaviour on teleporting.

interval *values*: float number greater or equal 0; *default*: `0.0`

The latency time after a teleport during which no further teleports take place.

freezable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.2 [freezable], page 183
liftable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.3 [liftable], page 184
portable, *values*: `true`, `false`; *default*: `false`; *access*: `read only` See Section 8.2.4 [portable], page 184

Messages:

signal See Section 6.2.3 [signal], page 130

A signal of value 1 switches the wormhole force on, a value of 0 switches the wormhole force off.

toggle See Section 6.2.1 [toggle], page 129

A toggle causes a change in the wormhole force activity state.

on See Section 6.2.4 [on], page 130

Switches the wormhole on.

off See Section 6.2.5 [off], page 130

Switches the wormhole off.

Action: none
Variants:

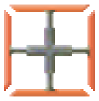
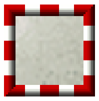
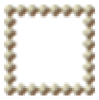
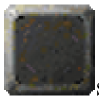
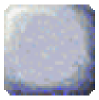
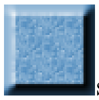
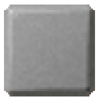
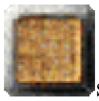
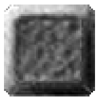
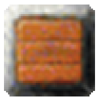
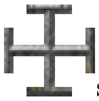
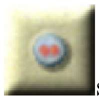
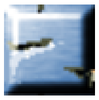
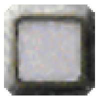
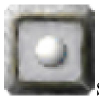
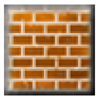
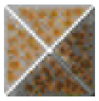
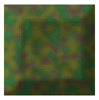
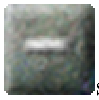
it_wormhole: state = `ON`.

it_wormhole_on: state = `ON`.

it_wormhole_off: state `OFF`.

9 Stone Objects

9.1 Stone Overview

	st_actorimpulse		st_ancient		st_barrier
	st_beads		st_blocker		st_boulder
	st_bluegray or st_thief		st_bluesand		st_blur_cross
	st_blur_straight		st_box_hay		st_box_rock
	st_box_wood		st_brake		st_break_black
	st_break_boulder		st_break_bug		st_break_oxydc
	st_break_plain		st_break_white		st_brick
	st_brownie		st_brownmarble		st_brownpyramid
	st_camouflage		st_charge_minus		st_charge_plus
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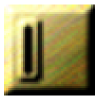
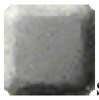
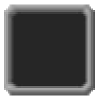
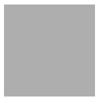
	st_coinslot		st_concrete		st_darkglass
	st_darkgray		st_death		st_disco_light
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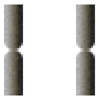
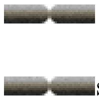
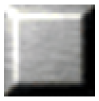
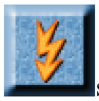
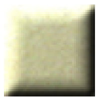
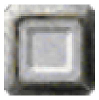
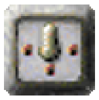
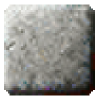
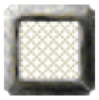
	st_door_d (ew)		st_door_d (ns)		st_dispenser_bombblack

	st_dispenser_bombwhit		st_dispenser_dynamite		st_dispenser_extralife
	st_fake_oxydc (open)		st_flash		st_flat
	st_floppy_off		st_floppy_on		st_fourswitch
	st_granite		st_grate_cross		st_grate_framed
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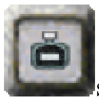
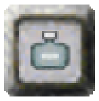
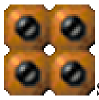
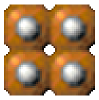
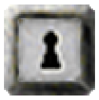
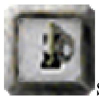
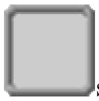
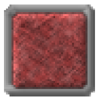
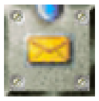
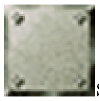
	st_invisible or st_ghost		st_inkwell_black		st_inkwell_empty
	st_inkwell_white		st_jamb_black		st_jamb_white
	st_key_off		st_key_on		st_knight
	st_laser		st_lightglass		st_lightpassenger
	st_mail		st_metal		st_mirror_triangle
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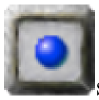
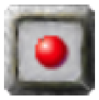
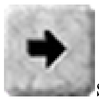
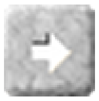
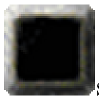
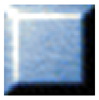
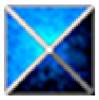
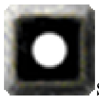
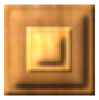
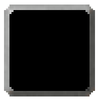
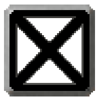
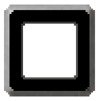
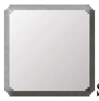
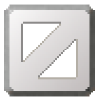
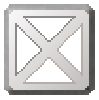
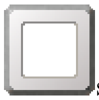
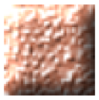
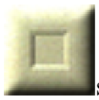
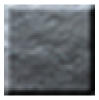
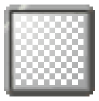
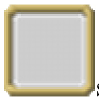
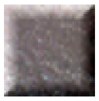
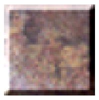
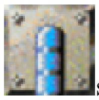
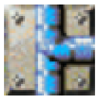
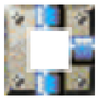
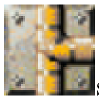
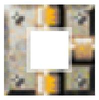
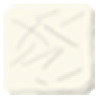
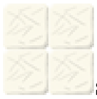
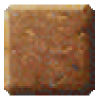
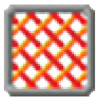
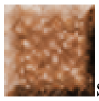
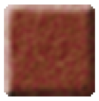
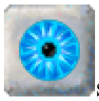
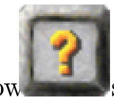
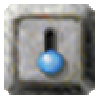
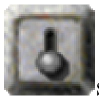
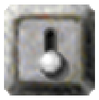
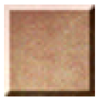
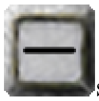
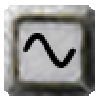
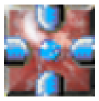
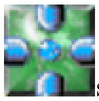
	st_mirror_sheets		st_monoflop		st_monoflop
	st_oneway		st_oneway_black		st_oneway_white
	st_oxyd_a		st_oxyd_b or st_quake or st_laserswitch		st_oxyd_c
	st_oxyd_d		st_oxyd_e		st_panel

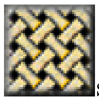
 st_passage_black	st_passage_black	 st_passage_black
 st_passage_black	 st_passage_white	 st_passage_white
 st_passage_white	 st_passage_white	st_pebble
 st_pinkbumps	 st_plaster	 st_plop_slate
 st_portal	 st_pull	 st_purplegray
 st_purplemarble	 st_puzzle_blue or st_turnstilearm_n	 st_puzzle_blue
 st_puzzle_blue	 st_puzzle_yellow	 st_puzzle_yellow
 st_rawglass	 st_rawglass_quad	 st_redbrown
 st_redfiber	 st_redmarble	 st_redrock
st_rotator_ccw	st_rotator_cw	st_rubberband
st_scissors	st_shogun_s	st_shogun_m
st_shogun_l	 st_spitter	st_stoneimpulse
st_stoneimpulse_hollow	 st_surprise	st_swap
 st_switch	 st_switch_black	 st_switch_white
st_thief	st_thief	st_thief
 st_tigris	 st_timer	 st_timer

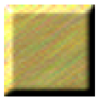

st_turnstile

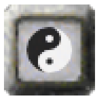

st_turnstile_green

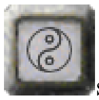
st_window

st_window


st_woven


st_yellow


st_yinyang


st_yinyang_inactive

9.2 Stone Attributes

9.2.1 breakable

Type: boolean
Values: `false`, `true`
Default: `false`
Access: read/write

9.2.2 freeze_check (stone)

If `true`, allows for Section 13.2.5 [Freeze Checking], page 395, for this stone. Note that Freeze Checking only works on those floors that have additionally set `freeze_check = true` on their own, see Section 7.2.10 [freeze_check (floor)], page 151.

Type: boolean
Values: `false`, `true`
Default: `false`
Access: read/write

9.2.3 hit_*

A set of attributes that allow you to distort hit forces. Objects like Section 9.5.22 [st_flash], page 262, Section 9.5.60 [st_spitter], page 302, and Section 9.5.1 [st_actorimpulse], page 242, apply forces that are either based on the hit velocity or the position.

By usage of a simple '`hit_strength`' factor you can increase, decrease or invert the default factor. Note that you must not set this attribute, if you want to use the default.

By setting the four attributes '`hit_distortion_xx`', '`hit_distortion_xy`', '`hit_distortion_yx`' and '`hit_distortion_yy`' you can describe a matrix to set up a new direction. These attributes default to 1, 0, 0, 1. A 90 degree clockwise turn is described by 0, 1, -1, 0.

Type: number
Values: ?
Default: factor - `nil`, xx, yy - `1`, xy, yx - `0`
By default no hit factor is applied. The hit matrix is the neutral one.

Access: read/write
Support: by some stones

9.2.4 hollow

Type: boolean
Values: `false`, `true`
Default: `false`
Access: read/write

9.2.5 hovering

Type: boolean
Values: `false`, `true`
Default: `false`
Access: read/write

9.2.6 movable

An attribute that describes if a stone is movable by actor impulses. It is supported by all stones.

Note that this attribute is not listed in the individual stone description if the stone is generally not movable.

Type: bool
Values: `true`, `false`
Default: usually `false`
If a stone exists only in a movable variant this attribute will default to '`true`'.

Access: read/sometimes write
This attribute is only writable for objects that exist in both variations.

Support: by all stones

9.2.7 transparent

Type: boolean
Values: `false`, `true`
Default: `false`
Access: read/write

9.3 Standard Stones

A standard stone is a passive wall stone. It might exist in a hollow or movable variant but provides no additional features.

9.3.1 st_ancient

A rough green gray rock that looks ancient.

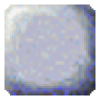
Variants:

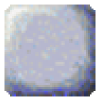
st_ancient

9.3.2 st_bluegray

A light blue gray stone that exists in all two variants. This stone is visually indistinguishable from a Section 9.5.65 [st_thief], page 308.

Variants:

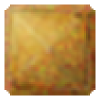
 **st_bluegray**

 **st_bluegray_hollow**

9.3.3 st_brownie

A golden, hay stack like stone that exists just in a movable variant.

Variants:

 **st_brownie**

9.3.4 st_brownmarble

A brown gray marble like stone.

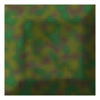
Variants:

st_brownmarble

9.3.5 st_camouflage

A military green camouflage stone that exists in all three variants.

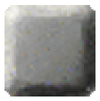
Variants:

 **st_camouflage**
st_camouflage_hollow
st_camouflage_movable

9.3.6 st_concrete

A polished light gray stone.

Variants:

 **st_concrete**

9.3.7 st_darkgray

A dark gray rock that exists in all two variants.

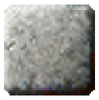
Variants:

st_darkgray
st_darkgray_hollow

9.3.8 st_granite

A light gray rock like stone that exists in all three variants.

Variants:

 **st_granite**
st_granite_hollow
st_granite_movable

9.3.9 st_greengray

A light green gray rock.

Variants:

st_greengray

9.3.10 st_invisible

An invisible stone that exists in all three variants. Please make rare usage of this stone as it may be very annoying to users to guess that a stone exists that he can not see. Use it to maintain the WYSIWYG expected behaviour.

Invisibility is not equal to laser transparency. In fact this stone is not laser transparent. And invisibility does not mean that an invisible actor can pass (see Section 9.6.1 [Transparent Stones], page 317).

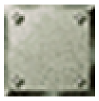
Variants:

st_invisible
st_invisible_hollow
st_invisible_movable

9.3.11 st_metal

A metal stone that exists in two variants.

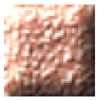
Variants:

 **st_metal**
st_metal_hollow

9.3.12 st_pinkbumps

A pink stone with heavy white bumps.

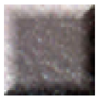
Variants:

 **st_pinkbumps**

9.3.13 st_purplegray

A dark purple gray rock.

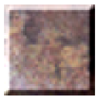
Variants:

 **st_purplegray**

9.3.14 st_purplemarble

A purple marble stone.

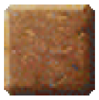
Variants:

 **st_purplemarble**

9.3.15 st_redbrown

A brown stone with light red touches that exists in all three variants.

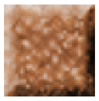
Variants:

 **st_redbrown**
st_redbrown_hollow
st_redbrown_movable

9.3.16 st_redmarble

A red white marbled stone.

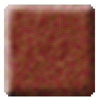
Variants:

 **st_redmarble**

9.3.17 st_redrock

A dark red rock.

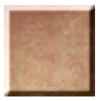
Variants:

 **st_redrock**

9.3.18 st_tigris

A red sandstone like Section 7.3.32 [fl_tigris], page 165.

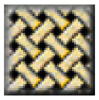
Variants:

 **st_tigris**

9.3.19 st_woven

A yellow gray woven stone.

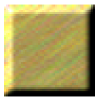
Variants:


st_woven

9.3.20 st_yellow

A yellow stone with red green stripes. This stone fits visually to the Section 9.5.14 [st_coinslot], page 253.

Variants:


st_yellow

9.4 Cluster Stones

A cluster stone is a passive wall stone like a simple stone. But several cluster stones adjacent to each other can visually build a cluster and look like a single big stone with a one common outer face.

9.4.1 Cluster Features

For each cluster stone there exist 16 different variations that represent all needed combinations of inner and outer faces to build arbitrary shaped big blocks.

There exist two methods of describing a special variation. You can either give the inner faces, the '`connections`', those sides that should be adjacent to other stones of the same cluster. Or you can give the outer faces, the '`faces`', that build the common outer face of the resulting big block.

As it is a tedious work to set up larger blocks by their single stones with appropriate faces you can rely on an automatic clustering feature. Just set the '`cluster`' attribute of all single stones of a big block to the same number and the faces will be set up automatically to form a large block.

You can build a screen of arbitrary big blocks and it is proven that there will never be the need of more than 4 different cluster numbers (the "4 color theorem"). But for convenience you are free to use additional cluster numbers as you like. Note that the autoclustering is quite dynamic. A single cluster stone with fitting cluster number that is swapped at the side of an existing block with the same cluster number will melt and join the block like seen in "Terminator 2".

We recommend making use of the autoclustering feature by setting the '`cluster`' attribute and using the '`faces`' attribute where necessary. '`connections`' attribute and explicit naming of variations by a suffix are deprecated, but will continue to be supported.

Attributes:

connections, *values*: string; *default*: `nil`
Describes the inner faces of stone. The string is a substring of `"nesw"` listing the inner faces. The sequence of the sides, north,

east, south, west, is guaranteed on read access but arbitrary on write access.

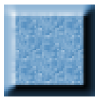
faces *values*: string; *default*: `nil`
Describes the outer faces of stone. The string is a substring of `"nesw"` listing the outer faces. The sequence of the sides, north, east, south, west, is guaranteed on read access but arbitrary on write access.

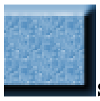
cluster *values*: number; *default*: `nil`
If set to a number all adjacent cluster stones of the same base type with the identical cluster number will build a big block. This attribute supersedes any explicitly given face description.

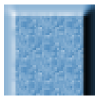
9.4.2 st_bluesand

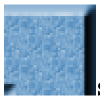
A standard cluster stone with the Section 9.4.1 [Cluster Features], page 239. It is recommended to use '`st_bluesand`' with the attributes '`cluster`' and '`faces`'.

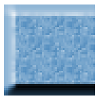
Variants:

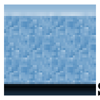

st_bluesand: connections = `""`

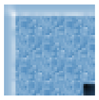

st_bluesand_w: connections = `"w"`

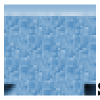

st_bluesand_s: connections = `"s"`

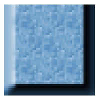

st_bluesand_sw: connections = `"sw"`

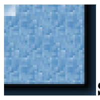

st_bluesand_e: connections = `"e"`

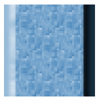

st_bluesand_ew: connections = `"ew"`

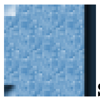

st_bluesand_es: connections = `"es"`

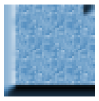

st_bluesand_esw: connections = `"esw"`

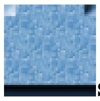

st_bluesand_n: connections = `"n"`

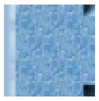

st_bluesand_nw: connections = `"nw"`

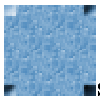

st_bluesand_ns: connections = `"ns"`


st_bluesand_nsw: connections = `"nsw"`


st_bluesand_ne: connections = `"ne"`


st_bluesand_new: connections = `"new"`

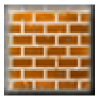
 **st_bluesand_nes**: connections = "nes"

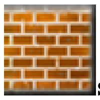
 **st_bluesand_nesw**: connections = "nesw"

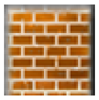
9.4.3 st_brick

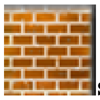
A standard cluster stone with the Section 9.4.1 [Cluster Features], page 239. It is recommended to use '`st_brick`' with the attributes '`cluster`' and '`faces`'.

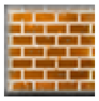
Variants:

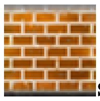
 **st_brick**: connections = ""

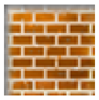
 **st_brick_w**: connections = "w"

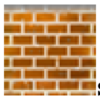
 **st_brick_s**: connections = "s"

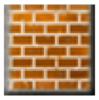
 **st_brick_sw**: connections = "sw"

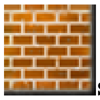
 **st_brick_e**: connections = "e"

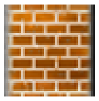
 **st_brick_ew**: connections = "ew"

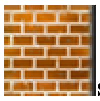
 **st_brick_es**: connections = "es"

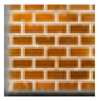
 **st_brick_esw**: connections = "esw"

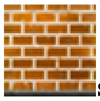
 **st_brick_n**: connections = "n"

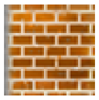
 **st_brick_nw**: connections = "nw"

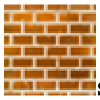
 **st_brick_ns**: connections = "ns"

 **st_brick_nsw**: connections = "nsw"

 **st_brick_ne**: connections = "ne"

 **st_brick_new**: connections = "new"

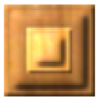
 **st_brick_nes**: connections = "nes"

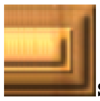
 **st_brick_nesw**: connections = "nesw"

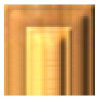
9.4.4 st_panel

A standard cluster stone with the Section 9.4.1 [Cluster Features], page 239. It is recommended to use '`st_panel`' with the attributes '`cluster`' and '`faces`'.

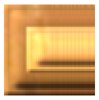
Variants:

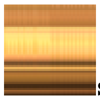
 **st_panel**: connections = ""

 **st_panel_w**: connections = "w"

 **st_panel_s**: connections = "s"

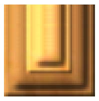
st_panel_sw: connections = "sw"

 **st_panel_e**: connections = "e"

 **st_panel_ew**: connections = "ew"

st_panel_es: connections = `"es"`

st_panel_esw: connections = `"esw"`


st_panel_n: connections = `"n"`

st_panel_nw: connections = `"nw"`

st_panel_ns: connections = `"ns"`

st_panel_nsw: connections = `"nsw"`

st_panel_ne: connections = `"ne"`

st_panel_new: connections = `"new"`

st_panel_nes: connections = `"nes"`

st_panel_nesw: connections = `"nesw"`

9.5 Special Stones

9.5.1 st_actorimpulse

An active bumper for actors and some stones like Section 9.5.6 [st_boulder], page 246. The actorimpulse stone can be made invisible while idle to introduce some surprise effects.

Actors that hit this stone will not be reflected just passively. An additional force will be applied to them that can even be distorted. By default the actors are just pushed away from the center of the stone. A global attribute Section 6.4.1 [ActorimpulseStrength], page 137, gives a default force that can be overridden by the stone attribute '`strength`'.

For sophisticated usage you can distort this force by usage of the Section 9.2.3 [hit_*], page 234, attributes. Note that the '`hit_factor`' overrides a '`strength`' attribute.

An actorimpulse stone can be configured by the '`invisible`' attribute to be hidden while being idle. While pulsing any actorimpulse is visible. An invisible actorimpulse can be made permanently visible by hitting it with a revealed Section 8.3.5 [it_brush], page 188, in the player's inventory. The level author can configure Section 8.3.16 [it_glasses], page 195, by addition of '`SPOT_ACTORIMPULSE`' to show otherwise invisible actorimpulse stones. With the global attribute Section 6.4.9 [ExtralifeGlasses], page 140, even glasses generated by laser lighting an Section 8.3.13 [it_extralife], page 193, can be configured to show invisible actorimpulse stones.

An Section 9.5.6 [st_boulder], page 246, hitting an actorimpulse stone will revert its orientation and return in the incoming direction.

Attributes:

invisible *values*: `true`, `false`; *default*: `false`
An invisible actorimpulse stone is totally transparent. But the user will notice it, as actors will bounce with additional impulses.

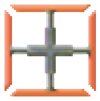
strength *values*: float number; *default*: `+200.0` See Section 6.4.1 [ActorimpulseStrength], page 137
A scalar factor for the impulse force. Positive numbers are attracting forces where as negative numbers are repelling forces.

hit_strength *values*: float number; *default*: `nil` See Section 9.2.3 [hit_*], page 234

A '`hit_strength`' overrides a given '`strength`' attribute.

hit_distortion_xx *values*: float number; *default*: `+1.0` See Section 9.2.3 [hit_*], page 234
hit_distortion_xy *values*: float number; *default*: `0.0` See Section 9.2.3 [hit_*], page 234
hit_distortion_yx *values*: float number; *default*: `0.0` See Section 9.2.3 [hit_*], page 234
hit_distortion_yy *values*: float number; *default*: `+1.0` See Section 9.2.3 [hit_*], page 234

Messages: none
Action: See Section 6.1.3 [target], page 126, See Section 6.1.4 [action], page 126
Variants:


st_actorimpulse: invisible = `false`

st_actorimpulse_invisible: invisible = `true`

9.5.2 st_barrier

The barrier stone blocks actors that carry a given item kind in their inventory. By blocking all entries to a given room by barriers of the same '`flavor`' you can assure that no actor can use the given item kind within the room, even when the item is available outside of the room. The barrier acts like customs service. The barrier performs a deep check investigating not only the top level of the actor's inventory. Every Section 8.3.1 [it_bag], page 184, will be checked recursively, too, ensuring that no instance of the searched item can pass the barrier.

The '`flavor`' attribute determines the blocked item kind. The string `"all"` blocks any item. Any string containing an Section 4.2.1 [Object Kind], page 49, will block items of just the given kind. Of course you can use just kinds of Section 8.2.4 [portable], page 184, items. E.g. a '`flavor`' of `"it_flag_white"` will just block actors that carry a white Section 8.3.14 [it_flag], page 194, while `"it_flag"` would block actors carrying flags of any color. The blocked item kind is indicated on top of the barrier stone.

Be aware that barrier stones can be circumvented with two actors exchanging their positions by Section 8.3.35 [it_yinyang], page 209, usage. As the player can not drop the Section 8.3.35 [it_yinyang], page 209, it is no use to add an additional barrier stone for this item. Multiple actors assigned to a single player are another potential shortcut of barrier stones.

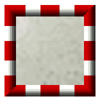
As barrier stones are usually bound to their initial position to fulfill their item blocking task, they are kept from being swapped or pulled by the '`static`' attribute's default of `true`.

Attributes:

flavor *values*: `"all"`, any portable item kind string; *default*: `"all"`
: The item kind to be searched for.

static *values*: `true`, `false`; *default*: `true`
: Static barriers are neither swappable nor pullable.

Messages: none
Action: none
Variants:

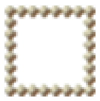

st_barrier: flavor=`"all"`

9.5.3 st_beads

A stone framed by glass beads. Like other Section 9.6.1 [Transparent Stones], page 317, it is passable for invisible actors, but it is not transparent to laser beams.

Like Section 9.5.43 [st_oneway], page 282, the beads stone does not detain visible actors once they entered the grid and lets them leave on any side.

Attributes: none
Messages: none
Variants:


st_beads

9.5.4 st_blocker

A door like object that shrinks to Section 8.4.1 [it_blocker], page 209, when hit by an Section 9.5.6 [st_boulder], page 246. When the boulder did pass the blocker stays in its item like open state until it is passed again by a boulder which causes it to grow again to a blocker stone.

It fully supports the messages of any door like object and can be opened and closed by any switch like object. Note that due to the transformation between stone and item during opening and closing you should name the blocker (see Section 6.1.1 [name], page 125) and address the blocker by this name. The complete identity with all attributes including any user attributes will be transferred between stone and item. E.g. '`{st_switch, target="myblocker", action="toggle"}`' will open and close a given blocker multiple times.

Note that the blocker is the only door object that allows a stone to be pushed through. Just boulders cause the growing. Any other stone keeps the open state.

Be aware that the Section 8.3.4 [it_brake], page 187, destroys an Section 8.4.1 [it_blocker], page 209.

Attributes:

state, *values*: `OPEN`, `CLOSED`; *default*: `CLOSED` See Section 6.1.2 [state], page 125
: The stone represents the closed state and will always return state '`CLOSED`'. But you can set its state what is equivalent to sending

an open message in case of value ‘OPEN’ and a close message in case of value ‘CLOSED’.

autoclose *values*: `true`, `false`; *default*: `false`
This attribute is irrelevant to the blocker stone itself. But it is transferred to the Section 8.4.1 [it_blocker], page 209, when the blocker opens.

Messages:

signal See Section 6.2.3 [signal], page 130
A signal of value 1 sends an open message, a signal of value 0 sends a close message.

toggle See Section 6.2.1 [toggle], page 129
A toggle causes an open unless the blocker stone is in the shrinking process. In this case it causes a close message.

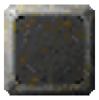
open See Section 6.2.6 [open], page 130
Starts an opening by shrinking the blocker. Note that during the shrinking process the blocker still reports to be closed. The shrinking process can be reverted by a close message.

close See Section 6.2.7 [close], page 131
A close message takes only effect on a blocker stone that is in the shrinking process. The shrinking is stopped immediately and reverted to grow the blocker again to full size.

Action: See Section 6.1.3 [target], page 126, See Section 6.1.4 [action], page 126
Sends an action at the moment the blocker reaches the closing state. That means an Section 8.4.1 [it_blocker], page 209, did close and did generate this blocker stone as its successor. The value will be ‘`false`’ to express the closing state.

Variants:

st_blocker
A standard blocker stone.


st_blocker_new
A blocker that just starts growing. Mainly used internally as the direct successor of an Section 8.4.1 [it_blocker], page 209. But it may be useful to generate an initial snapshot of a moving boulder over a blocker line, too. See example levels.

9.5.5 st_blur

A gray stone that transforms on an actor hit into a Section 9.5.45 [st_passage], page 287, depending on the color of actor. The color of the passage may be the same as the color of the actor or be of the opposite color. The flavor of the passage is always `"square"`.

In the first case the blur stone is pure gray and its '`flavor`' is called `"straight"` due to the straight color preserving transformation. The touching actor will be able to pass the passage straight away.

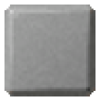
In the second case the blur stone has an added white and black symbol to notify the player that, on touching the stone with a colored actor, this actor will not be able to pass the resulting passage. There are two flavors of such blur stones - `"cross"` which transform unconditionally on an actor hit to the opposite colored Section 9.5.45 [st_passage], page 287, and flavor `"magic"` which transforms just on actors hitting the blur stone with a revealed Section 8.3.19 [it_magicwand], page 197, or Section 8.3.5 [it_brush], page 188, in their inventory.

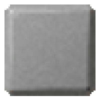
For colorless actors a blur stone is just a standard stone without any special features.

Attributes:

flavor *values*: `"straight"`, `"cross"`, `"magic"`; *default*: `"straight"`
The blur subkind.

Messages: none
Action: none
Variants:


st_blur: flavor = `"straight"`


st_blur_straight: flavor = `"straight"`

st_blur_cross: flavor = `"cross"`

st_blur_magic: flavor = `"magic"`

9.5.6 st_boulder

This solid stone moves into the direction shown by the arrow on its picture. A marble blocking its way is shattered. When a stone blocks its way, the boulder triggers it by a sequence of two internal messages. Some stones give way like Section 9.5.4 [st_blocker], page 244, '`st_break_boulder`' (see Section 9.5.9 [st_break], page 250), others change their state like Section 9.5.44 [st_oxyd], page 284, Section 9.5.61 [st_stoneimpulse], page 304, Section 9.5.53 [st_quake], page 297, Section 9.5.41 [st_mirror], page 278, Section 9.5.25 [st_fourswitch], page 264, Section 9.5.69 [st_volcano], page 312. A third category switches temporarily into another state on the first message sent when the boulder reaches a grid and switches back on the second message sent when the boulder gives up like Section 9.5.45 [st_passage], page 287, Section 9.5.23 [st_flat], page 262, Section 9.5.38 [st_lightpassenger], page 275.

Items getting beneath a moving boulder may react like on any other stone move on top of them. Additionally Section 8.4.1 [it_blocker], page 209, will be released to grow again to a blocking stone.

Boulder stones fall into Section 7.4.1 [fl_abyss], page 166, but cross Section 7.4.13 [fl_water], page 178, unchanged.

Section 8.3.19 [it_magicwand], page 197, and lasers reverse its orientation. An Section 9.5.1 [st_actorimpulse], page 242, reverts the orientation if the boulder hits it frontally. An Section 9.5.56 [st_rotator], page 298, changes its orientation according to the rotator's direction. An Section 9.5.61 [st_stoneimpulse], page 304, pushes a boulder away.

Attributes:

orientation, *values*: `NORTH`, `EAST`, `SOUTH`, `WEST`; *default*: `NORTH`
The orientation of the boulder that is shown by its arrow. It determines the direction that the boulder will take on its next move.

counterclock *values*: `true`, `false`; *default*: `false`
The standard turning direction is clockwise. Use this attribute to revert the direction.

Messages:

orientate, *value type*: direction
Change the orientation to the given orientation value. The Section 9.5.25 [st_fourswitch], page 264, provides a compatible action which allows you to set a boulder as target and this message as action.

turn Turn orientation in turning direction as defined by attribute '`counterclock`'.

turnback Turn orientation in opposite turning direction as defined by attribute '`counterclock`'.

flip Turn orientation into the reverse of the current orientation.

Action: none

Variants:

st_boulder

st_boulder_n: orientation = `NORTH`

st_boulder_e: orientation = `EAST`

st_boulder_s: orientation = `SOUTH`

st_boulder_w: orientation = `WEST`

9.5.7 st_box

A movable, floor building stone of various flavors.

This very common stone is well known in its default flavor `"wood"`. But it exists in the flavors `"hay"` and `"rock"`, too. The flavor `"wood"` has a random wood tile orientation. You can set wooden boxes of given tile orientation by the variants `st_box_wood_h` and `st_box_wood_v`.

The flavors `"wood"` and `"hay"` may originate from a growing Section 8.3.26 [it_seed], page 203. Due to the Section 4.4.2 [Snapshot Principle], page 58, special box variants exist just for usage in level initialization: `st_box_wood_growing` and `st_box_hay_growing`.

All variants can easily be pushed around, do press Section 8.4.18 [it_trigger], page 226s and do fall into Section 7.4.1 [fl_abyss], page 166, Section 7.4.13 [fl_water], page 178, and Section 7.4.11 [fl_swamp], page 177, by building a framed floor of the kind indicated by their '`flavor`' attribute. All boxes will fall on the first occasion. Even if they receive two push impulses at the same time by Section 11.1.3 [ot_wire], page 331, they fall on the first grid. Thus it is impossible to push a box over a ditch. Boxes will fall if the floor beneath them vanishes. E.g. an Section 8.4.2 [it_bomb], page 211, explosion beneath a box may change the floor to Section 7.4.1 [fl_abyss], page 166, or a flood stream may change the floor to Section 7.4.13 [fl_water], page 178. In all these cases the box above falls immediately building its kind of floor.

Note that all boxes do actively support Section 13.2.2 [Flood Spreading], page 390. That means that they let an arriving flood stream flow beneath them. In case the floor beneath the box is floodable it will change to water and the box will fall. The new built floor itself conserves the flood stream feature and will let the stream flood neighboring floodable floors, too. (see Section 7.4.14 [fl_wood], page 179, Section 7.4.5 [fl_hay], page 171, Section 7.4.8 [fl_rock], page 173).

The box flavors do differ in some small but essential features. Whereas the flavors `"wood"` and `"rock"` do cause an Section 8.4.2 [it_bomb], page 211, to explode when being pushed over it, a `"hay"` flavored box does not ignite bombs.

According to their flavor `"wood"` and `"hay"` will burn on fire. But `"rock"` flavored boxes are fire resistant and fire blocking.

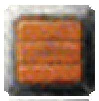
Attributes:

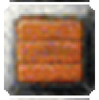
flavor *values*: `"wood"`, `"hay"`, `"rock"`; *default*: `"wood"`; *access*: read only

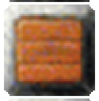
secure *values*: `true`, `false`; *default*: `false`

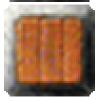
This attribute is inherited to a floor build by a falling box and guarantees then secure fire burning.

Messages: none
Action: none
Variants:

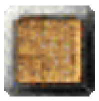
**st_box**: flavor="wood"

**st_box_wood**: flavor="wood"

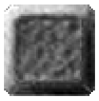
**st_box_wood_h**: flavor="wood"

**st_box_wood_v**: flavor="wood"

st_box_wood_growing: flavor="wood"

**st_box_hay**: flavor="hay"

st_box_hay_growing: flavor="hay"

**st_box_rock**: flavor="rock"

9.5.8 st_brake

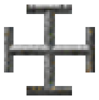
The brake stone can be used to block a running Section 9.5.6 [st_boulder], page 246, or a Section 9.5.38 [st_lightpassenger], page 275, what likely has given this object its name. But unlike all other blocking stones the brake can be picked up as an item by actors and dropped anywhere else.

When an actor passes a brake stone, rolling on the floor or while jumping, it will pick up the object like other items. The brake will be added as an Section 8.3.4 [it_brake], page 187, to its inventory. Unlike other items the brake can be dropped even on grids that are already occupied by an item. But you can not drop the brake beneath another stone like an Section 8.3.26 [it_seed], page 203.

On dropping the brake item it transforms immediately back to an Section 9.5.8 [st_brake], page 249, without killing the item positioned on the grid. Just one exception is a brake being dropped on top of an Section 8.4.1 [it_blocker], page 209, what results in an elimination of the blocker. On the other hand a brake stone will press an Section 8.4.18 [it_trigger], page 226, beneath, what makes the brake item a portable trigger key.

The brake stone explodes when it is exposed to laser light or an Section 8.4.2 [it_bomb], page 211, explosion on a direct neighbor grid.

Attributes: none
Messages: none
Action: none
Variants: none

**st_brake**

9.5.9 st_break

A stone of various flavors that is breakable under various conditions. The stone may be breakable by actors of some kind, with or without an item, by an igniting explosion on a neighboring grid and in most cases by laser light. Besides being breakable the stone is a standard stone. The different flavors let this stone appear in quite different outlooks.

The flavor `"plain"` is a grey stone that is breakable by any actor hit with a revealed Section 8.3.17 [it_hammer], page 196, and by a laser beam hitting any side.

The flavors `"black"` and `"white"` look similar to the `"plain"` variant just with a small colored ball sitting on top. But these variants are just breakable by any actors of matching color. Of course the actors need a revealed Section 8.3.17 [it_hammer], page 196. Laser beams do break the stone, too.

The flavor `"oxydc"` looks like a cracked Section 9.5.44 [st_oxyd], page 284, of flavor `"c"`. Like the `"plain"` variant it is breakable by any actor hit with a revealed Section 8.3.17 [it_hammer], page 196, and by a laser beam hitting any side.

The flavor `"boulder"` looks like a yellowish version of flavor `"oxydc"`. It is breakable under the same conditions plus additionally by an Section 9.5.6 [st_boulder], page 246, hitting on one of its sides.

The flavor `"bug"` looks like an Section 9.5.23 [st_flat], page 262, with a bug symbol on top. It is just breakable by an Section 10.2.1 [ac_bug], page 322. No other actor and no laser light will break it.

The flavor `"laser"` looks identical to an Section 9.5.23 [st_flat], page 262. It is not breakable by actors. Just laser light beams on one of its faces will break this variant.

All but the variant `"bug"` will break on neighboring ignitions like those caused by an exploding Section 8.3.11 [it_dynamite], page 192, on a direct neighboring position or an exploding black Section 8.4.2 [it_bomb], page 211, on a diagonal neighboring position.

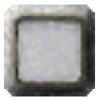
Attributes:

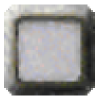
flavor *values*: `"plain"`, `"black"`, `"white"`, `"oxydc"`, `"boulder"`, `"bug"`, `"laser"`; *default*: `"plain"`; *access*: read only

Messages:

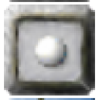
ignite Break stone with exception of flavor `"bug"`.

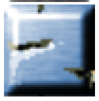
Action: none
Variants:

**st_break**: flavor=`"plain"`

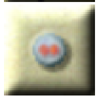
**st_break_plain**: flavor=`"plain"`

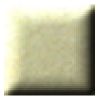
st_break_black: flavor=`"black"`

**st_break_white**: flavor=`"white"`

**st_break_oxydc**: flavor=`"oxydc"`

st_break_boulder: flavor=`"boulder"`

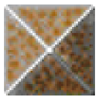
**st_break_bug**: flavor=`"bug"`

**st_break_laser**: flavor=`"laser"`

9.5.10 st_brownpyramid

A brown gray pyramid shaped stone. This stone is just standard stone besides the fact that it can be destroyed by an Section 11.1.1 [ot_cannonball], page 330, emitted by an Section 9.5.60 [st_spitter], page 302, that happens to fall on its top.

Variants:

**st_brownpyramid**

9.5.11 st_chameleon

A stone that has no own image but mimics the floor beneath. Thus it is fairly invisible. But as it shows the same image as the floor it hides items and even actors on the grid. The stone is hovering, thus it does not press any Section 8.4.18 [it_trigger], page 226, and lets pass any actors and laser light, too.

Please make rare usage of this stone in Enigma 1.1* as the current display engine does not really support this stone. All dynamic floors and floor changes do cause faulty displays. Thus use it currently only in patterns without any floor dynamics.

Variants:

st_chameleon

9.5.12 st_charge

An electrical charger for actors. The image reflects the sign of the '`charge`' attribute.

Any actor hitting this stone will recharge its Section 10.1.2 [charge], page 320, attribute to the value given by the stone's '`charge`' attribute.

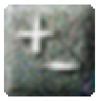
The stone itself does not cause any electrical forces. It is neither attracting nor repelling for charged actors. Electrical forces applied to actors just depend on the charges of different actors and the global attribute Section 6.4.8 [ElectricStrength], page 139.

Attributes:

charge *values*: floating point numbers; *default*: `0.0`
The charge applied to hitting actors.

Messages: none
Action: none
Variants:

st_charge: charge = `0.0`


st_charge_zero: charge = `0.0`

st_charge_plus: charge = `+1.0`

st_charge_minus: charge = `-1.0`

9.5.13 st_chess

A chess stone is like a chess knight. It exists in the two colors black and white, it can jump and make a chess knight move. It can even beat stones at the target position.

A black chess can only be moved with a black marble, a white one with white marbles. The jump direction is given by the marble hit direction. It moves two grid steps into the direction, into which other movable stones move just one grid, plus one grid step vertical. The vertical direction is given by the marbles vertical velocity component.

When there is a chess stone of opposite color or an Section 9.5.65 [st_thief], page 308, at the target position of a knight move, this stone is captured and destroyed.

When hit with a revealed Section 8.3.19 [it_magicwand], page 197, a chess stone changes color.

Chess stones fall into Section 7.4.1 [fl_abyss], page 166, and sink in Section 7.4.11 [fl_swamp], page 177, but cross Section 7.4.13 [fl_water], page 178, undamaged.

A chess stone that jumps onto a Section 7.4.12 [fl_thief], page 178, captures and inactivates the thief.

Chess stones can't jump over or into fire (see Section 13.2.3 [Fire Spreading], page 392). At least, a chess knight is brave enough not to panic when fire starts to burn beneath. Note that fire can't ignite the floor below a chess stone. In this context it acts like an immovable stone. In the same sense, they don't act on stone impulses of Section 9.5.61 [st_stoneimpulse], page 304, or Section 8.3.23 [it_puller], page 200.

Attributes:

color *values*: `BLACK`, `WHITE`; *default*: `BLACK`
The color of the chess stone

movable *values*: `true`; *default*: `true` See Section 9.2.6 [movable], page 235
Read only attribute that states the ability of a chess stone to move.

Messages:

flip Flip the color of the stone.

move, *value type*: position; *values*: `NNE`, `NEE`, `SEE`, `SSE`, `SSW`, `SWW`, `NWW`, `NNW`
Jump into the given direction.

Action: none
Variants:

st_chess: color = `BLACK`

st_chess_black: color = `BLACK`

st_chess_white: color = `WHITE`

9.5.14 st_coinslot

A switch that is activated by insertion of an Section 8.3.8 [it_coin], page 190. Just actors assigned to a player can insert coins out of their item inventory by hitting the coinslot with the coin being the first item. Depending on the coin type the coinslot remains in state '`ON`' for a given '`interval`' before switching back to state '`OFF`'. Multiple inserted coins do prolong the activity interval.

Standard not '`instant`' coinslots do activate after the insertion process of the coin. No additional coins can be inserted while another coin is being inserted. This prevents unintended multiple coin insertions. On the other hand the player has to insert additional coins early enough to prolong the active state without temporarily switching back to '`OFF`' state. If the first interval runs off while the next coin did not yet finish its insertion the coinslot will first switch '`OFF`' and switch '`ON`' when the next coin is completely inserted.

The activity interval of a coin insertion depends on the type of the coin. For each type you can set the interval by the '`interval_*`' attributes. You can reject the insertion of a coin type by setting its interval to '`COIN_REJECT`'. The coin will not be taken from the player's inventory. By a value of '`COIN_IGNORE`' on the interval attribute the coinslot will fetch the coin but will not act at all.

Coinslots configured as '`instant`' do activate immediately when the actor hits the stone. On every actor hit a coin is inserted independent of the last insertion.

The '`state`' of a coinslot can be requested but it can not be set, neither by attribute nor by messages.

Attributes:

state, *values*: `ON`, `OFF`; *default*: `OFF`; *access*: `read only` See Section 6.1.2 [state], page 125
: Current activity state of the coinslot.

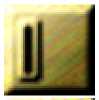
instant *values*: `true`, `false`; *default*: `false`
: A default coinslot switches to active state after insertion of a coin and allows the insertion of just one coin at a time.

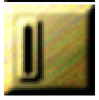
interval_s *values*: positive number, `COIN_REJECT`, `COIN_IGNORE`; *default*: `3.0`
: Number of additional active seconds on insertion of a small Section 8.3.8 [it_coin], page 190.

interval_m *values*: positive number, `COIN_REJECT`, `COIN_IGNORE`; *default*: `6.0`
: Number of additional active seconds on insertion of a medium Section 8.3.8 [it_coin], page 190.

interval_l *values*: positive number, `COIN_REJECT`, `COIN_IGNORE`; *default*: `12.0`
: Number of additional active seconds on insertion of a large Section 8.3.8 [it_coin], page 190.

Messages: none
Action: See Section 6.1.3 [target], page 126, See Section 6.1.4 [action], page 126
Variants:

**st_coinslot**: instant = `false`

**st_coinslot_instant**: instant = `true`

9.5.15 st_darkglass

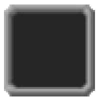
A metal framed semi transparent glass stone. It exists in static, movable and hollow variants and is just transparent to laser light in its hollow variant. Like other Section 9.6.1 [Transparent Stones], page 317, it is passable for invisible actors as long as it is not '`movable`'.

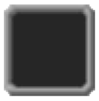
A Section 9.5.38 [st_lightpassenger], page 275, in state '`OFF`' looks identical to a darkglass stone

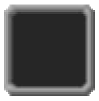
Attributes:

hollow *values*: `true`, `false`; *default*: `false`; *access*: read only See Section 9.2.4 [hollow], page 235
movable *values*: `true`, `false`; *default*: `false`; *access*: read only See Section 9.2.6 [movable], page 235

Messages: none
Variants:

**st_darkglass**: hollow = `false`, movable = `false`

**st_darkglass_hollow**: hollow = `true`, movable = `false`

**st_darkglass_movable**: hollow = `false`, movable = `true`

9.5.16 st_death

Shatters any Section 10.2.4 [ac_marble], page 325, and Section 10.2.5 [ac_pearl], page 326, that hits or even just touches it. Just marbles and pearls protected by an activated Section 8.3.32 [it_umbrella], page 207, will bounce unharmed as other actors do which will not die anyway.

Death stones can be configured by the '`invisible`' attribute to be hidden while being idle. When hit by an actor any death stone becomes temporary visible. An actor with unbroken standard Section 8.3.16 [it_glasses], page 195, in its inventory will be able to spot invisible death stones.

The level author can configure Section 8.3.16 [it_glasses], page 195, by elimination of '`SPOT_DEATH`' not to show invisible death stones. With the global attribute Section 6.4.9 [ExtralifeGlasses], page 140, even glasses generated by laser lighting an Section 8.3.13 [it_extralife], page 193, can be configured not to show invisible actorimpulse stones.

A death stone can also be movable. Of course ball like actors can not push it. But other actors can push it. A movable death stone can be connected by an Section 11.1.3 [ot_wire], page 331, to another movable stone that allows to control it. Furtheron all stones emitting stone impulses like Section 9.5.61 [st_stoneimpulse], page 304, Section 9.5.56 [st_rotator], page 298, Section 9.5.38 [st_lightpassenger], page 275, can move it. And finally a pushing Section 9.5.6 [st_boulder], page 246, will move it until an obstacle stops the death stone.

A movable death stone looks identical to the static default version. But from time to time it will show its animation and can thus be identified by the user. The interval of the animations is determined by the attribute '`interval`', but will randomly vary up to 20% from the given value. When the '`interval`' equals zero no animation will reveal the movable death. But any Section 8.3.16 [it_glasses], page 195, capable of '`SPOT_DEATH`' will show the movable death in a lighter stone color than the static ones.

A '`movable`' death can not be '`invisible`' at the same time. If you set both attributes the last attribute set wins and resets the first one.

Attributes:

state, *values*: `ON`, `OFF`; *default*: `OFF`; *access*: `read only` See Section 6.1.2 [state], page 125

Current activity state of the death stone. A stone is usually activated by a hitting actor.

invisible *values*: `true`, `false`; *default*: `false`

Invisible death stones show only when hit by an actor or been toggled by a message. Setting this attribute to '`true`' sets '`movable`' to '`false`'.

movable *values*: `true`, `false`; *default*: `false`; See Section 9.2.6 [movable], page 235

Movable death stone. Setting this attribute to '`true`' sets '`invisible`' to '`false`'.

interval *values*: positive number; *default*: `10.0`

Number of seconds to show animation on movable death.

Messages:

toggle See Section 6.2.1 [toggle], page 129

Temporarily activate the stone to show its animation and to get visible for this period.

Action: none

Variants:

st_death: invisible = `false`

st_death_invisible: invisible = `true`

st_death_movable: movable = `true`

9.5.17 st_disco

A free passable stone, which darkens everything that is underneath the stone. It looks like a tinted glass that occurs in several shades. It likely got its name from the possibility to switch between the shade grades.

The disco stone comes in three variants, '`LIGHT`', '`MEDIUM`' and '`DARK`'. The dark variant is pure black, that shows neither actors, items or the floor. You can switch between these variants by messages and state attribute access. The messages `"lighten"` and `"darken"` change the shade by one degree. The message `"signal"` turns the disco light full on or off, independent of the previous state. The standard `"toggle"` switches from light `->` medium `->` dark `->` light.

Note: unlike the old API versions of this stone, it does no longer support recursive shading of neighboring disco stones. Make use of object groups by Section 4.2.3 [Object Naming], page 50, to shade groups of arbitrary composition by a single message.

Attributes:

state, *values*: `LIGHT`, `MEDIUM`, `DARK`; *default*: `LIGHT` See Section 6.1.2 [state], page 125

The shading grade.

Messages:

lighten Lighten by one degree.

darken Darken by one degree.

signal See Section 6.2.3 [signal], page 130

Switch to '`LIGHT`' on a value of `1`. Switch to '`DARK`' on a value of `0`.

toggle See Section 6.2.1 [toggle], page 129
Darken by degree or switch from '`DARK`' to '`LIGHT`'

Action: none
Variants:

st_disco: state = `LIGHT`

st_disco_light: state = `LIGHT`

st_disco_medium: state = `MEDIUM`

st_disco_dark: state = `DARK`

9.5.18 st_dispenser

An item dispenser in some item flavors.

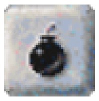
On every actor hit the dispenser adds a new item given by the attribute '`flavor`', namely Section 8.4.2 [it_bomb], page 211, in color black or white, Section 8.3.11 [it_dynamite], page 192, or Section 8.3.13 [it_extralife], page 193, to the inventory of the actor's owner. Of course an item will just be added if the inventory is capable of adding a further item. Additionally the dispenser's '`stock`' must supply a further item. The default stock of 1000 items should be enough for usual demands. But you can limit the supply to just a few counted items. This '`stock`' attribute gets decremented every time an actor takes an item.

The dispenser stone does break on adjacent Section 8.4.2 [it_bomb], page 211, explosions and adjacent dispenser stone breaks. On its break it will itself cause adjacent Section 8.3.11 [it_dynamite], page 192, to ignite, Section 8.4.2 [it_bomb], page 211, positioned beneath itself to explode, and of course neighboring dispensers to break. Dispenser stones will neither break on actor hits, even with a revealed hammer, nor on laser light beams.

Attributes:

flavor *values*: `"bombblack"`, `"bombwhite"`, `"dynamite"`, `"extralife"`; *default*: `"bombblack"`;
stock, *values*: integer numbers; *default*: `1000`: See Section 6.1.2 [state], page 125

Messages: none
Action: none
Variants:

**st_dispenser**: flavor=`"bombblack"`

st_dispenser_bombblack: flavor=`"bombblack"`

st_dispenser_bombwhite: flavor=`"bombwhite"`

st_dispenser_dynamite: flavor=`"dynamite"`

st_dispenser_extralife: flavor=`"extralife"`

9.5.19 st_document

This stone can display a text message when touched. Other message carrying items are Section 8.3.9 [it_document], page 190, and Section 8.3.3 [it_bottle], page 186.

In addition, this is the paper member of the rock-paper-scissors trio, the other two stones being Section 9.5.58 [st_scissors], page 300, and Section 9.5.46 [st_pebble], page 288. When `st_document` is touched, each `st_pebble` bordering it or being connected to it by a wire is destroyed. Similarly, when an `st_scissors` is touched, that borders or is connected to an `st_document`, the `st_document` will break.

Attributes:

text, *values*: string;
Either the text to be displayed or just a key word for identification on Section 3.5 [Internationalization (i18n)], page 39. It may be empty (then no text is displayed).

Messages: none
Action: none
Variants:

st_document

9.5.20 st_door

Doors are stones that let actors pass or block them to enter the grid, depending on their state. Doors can be opened and closed by the standard set of messages. Doors do not open or close instantly. They need a small amount of time. Actors can pass only doors that are completely open.

There are several flavors of doors. The variants `"a"` to `"c"` represent grid filling block doors. Flavor `"a"` looks in the closed state like Section 9.5.44 [st_oxyd], page 284, of flavor `"a"` and in the opened state like an Section 9.5.27 [st_grate], page 266, of flavor `"cross"`. Flavor `"b"` looks in the closed state like Section 9.5.23 [st_flat], page 262, but opens to an invisible, free passable, but still existing and grid blocking stone. Flavor `"c"` looks in the closed state like Section 9.5.23 [st_flat], page 262, and in the opened state like an Section 9.5.27 [st_grate], page 266, of flavor `"framed"`. The flavor `"d"` represents a faces based door, that opens or blocks just the given faces of the grid. Currently just the combinations of two parallel aligned door faces, aka horizontal and vertical doors, are supported.

As door grids can be entered on unfaced sides you should block these faces by impassable stones. If you do not block these entries or even allow marbles to warp into a door, the actors will be free to leave the doors even if they are closed. But marbles will shatter on the door grid when doors are closed. This behaviour is a legacy Enigma feature.

Doors are stones that are even present if they are not visible in the `OPEN` state. This means you can not push or move any other stone through an open door. The Section 9.5.4 [st_blocker], page 244, is a quite compatible door alternative that allows stones to pass in its open state.

All doors are hovering and will not press Section 8.4.18 [it_trigger], page 226s. Thus you can detect passing actors by positioning a trigger beneath a door. Doors will neither press Section 7.4.2 [fl_bridge], page 167, and will thus take no influence on the bridge.

Laser light will pass any open door, but will be blocked by closed faces. Closed doors of type `"d"` let light pass if the faces are parallel aligned to the light without intervening the light.

Just doors of type `"d"` allow an actor to knock on its closed faces. This causes an action that might open the door or do anything else. A common target is Section 9.5.31 [st_jamb], page 270, that evaluated the color of the knocking actor. The door has to be completely closed; opening or closing doors do not cause an action on knocking.

Doors do support Section 13.2.2 [Flood Spreading], page 390, and Section 13.2.3 [Fire Spreading], page 392, through open faces and generally in '`OPEN`' state.

Attributes:

state, *values*: `OPEN`, `CLOSED`; *default*: `CLOSED`; See Section 6.1.2 [state], page 125

The open state of the door. On read access it reports if the door is completely opened and passable for actors. Note that a door reaches the state '`OPEN`' after the finish of the opening animation, what is an essential amount of time after the initiating `"open"` message. But on a `"close"` message the state turns immediately to '`CLOSED`' as actors are blocked immediately. On write access a state change causes a proper message and may occur with a delay, too.

flavor *values*: `"a"`, `"b"`, `"c"`, `"d"`; *default*: `"d"`

Representing different door types as described above. Block based flavors `"a"`, `"b"`, `"c"` and the face based flavor `"d"`.

faces *values*: string; *default*: `"nesw"`

Describes the door faces of the stone. The string is a substring of `"nesw"` listing the faces. The sequence of the sides, north, east, south, west, is guaranteed on read access but arbitrary on write access. Note that the supported face combinations depend on the flavor. All but flavor `"d"` do always provide all 4 faces. Flavor `"d"` currently supports the face combinations `"ns"` and `"ew"`, in other words horizontal and vertical aligned door faces, with the first combination being the default.

Messages:

open See Section 6.2.6 [open], page 130
Opens a closed door or reverses the process of a closing door.

close See Section 6.2.7 [close], page 131
Closes an open door or reverses the process of an opening door.

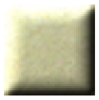
signal See Section 6.2.3 [signal], page 130
Opens at value '`1`', and closes at value '`0`'.

Action: Just flavor `"d"` doors will perform an action on an actor touching a face of a closed door. The action value will be the actor object, which can be evaluated on its kind. This action value fits the '`hit`' messages of objects like Section 9.5.31 [st_jamb], page 270. The door has to be completely closed; opening or closing doors do not cause an action on knocking.

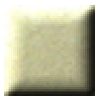
Variants:

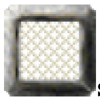
st_door_a: flavor = `"a"`, state = `CLOSED`

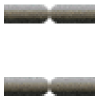
st_door_a: flavor = `"a"`, state = `OPEN`

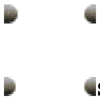

st_door_b: flavor = `"b"`, state = `CLOSED`

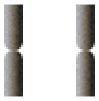
st_door_b: flavor = `"b"`, state = `OPEN`

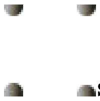

st_door_c: flavor = `"c"`, state = `CLOSED`


st_door_c: flavor = `"c"`, state = `OPEN`


st_door_d: flavor = `"d"`, faces = `"ns"`, state = `CLOSED`


st_door_d: flavor = `"d"`, faces = `"ns"`, state = `OPEN`


st_door_d: flavor = `"d"`, faces = `"ew"`, state = `CLOSED`


st_door_d: flavor = `"d"`, faces = `"ew"`, state = `OPEN`

9.5.21 st_fake

A stone that mimics other stones, but does not act like them.

In contrast to Section 9.5.39 [st_magic], page 276, the fake stone does not transform but remains all time a passive variant of the stone that it models. The stone does look like another stone of the kind given by the attribute '`flavor`'. The fake stone may even mimic state dependent behaviour with state dependent models and animations.

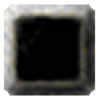
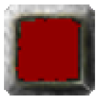
The flavor `"quake"` mimics a Section 9.5.53 [st_quake], page 297, including the pulsing animation on actor hits and state changes, but does not cause any Section 9.5.44 [st_oxyd], page 284, to close.

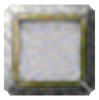
The flavors `"oxyda"`, `"oxydb"`, `"oxydc"`, `"oxydd"`, `"oxyde"` mimic Section 9.5.44 [st_oxyd], page 284, of appropriate flavor, but they are just passive stones. Nevertheless they are aware of a state ‘`OPEN`’ and will display the corresponding base image of the open oxyd stone, of course without any color spot.

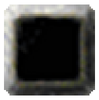
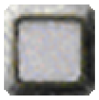
Attributes:

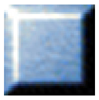
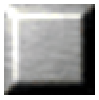
flavor *values*: `"quake"`, `"oxyda"`, `"oxydb"`, `"oxydc"`, `"oxydd"`, `"oxyde"`; *default*: `"quake"`;
state, *values*: `CLOSED`, `OPEN`; *default*: `CLOSED`: See Section 6.1.2 [state], page 125

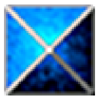
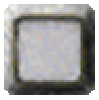
Messages: none
Action: none
Variants:

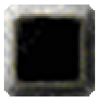


st_fake_quake:
st_fake_quake: flavor=`"quake"`, state=`ACTIVE`
flavor=`"quake"`,
state=`IDLE`

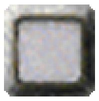

st_fake_oxyda:
st_fake_oxyda: flavor=`"oxyda"`, state=`OPEN`
flavor=`"oxyda"`,
state=`CLOSED`



st_fake_oxydb:
st_fake_oxydb: flavor=`"oxydb"`, state=`OPEN`
flavor=`"oxydb"`,
state=`CLOSED`



st_fake_oxydc:
st_fake_oxydc: flavor=`"oxydc"`, state=`OPEN`
flavor=`"oxydc"`,
state=`CLOSED`



st_fake_oxydd:
st_fake_oxydd: flavor=`"oxydd"`, state=`OPEN`
flavor=`"oxydd"`,
state=`CLOSED`


st_fake_oxyde: flavor="oxyde", state=CLOSED


st_fake_oxyde: flavor="oxyde", state=OPEN

9.5.22 st_flash

A stone symbolized by a yellow flash, that forwards actors' hits as a force to matching partner actors.

Just Section 10.2.4 [ac_marble], page 325, actors are affected. A black hitting marble will push the first white marble, and vice versa. The hitting marble's velocity is multiplied to a distortion matrix given by four single attributes. The default matrix does maintain the direction. The resulting vector is again multiplied by a linear strength factor. The resulting force vector is applied to the partner marble. If no matching marble exists no forces are applied. The hitting marble bounces on the flash stone as on any other standard stone.

Attributes:

hit_strength *values*: floating point numbers; *default*: `20.0`; See Section 9.2.3 [hit_*], page 234

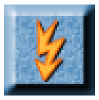
hit_distortion_xx *values*: floating point numbers; *default*: `1.0`; See Section 9.2.3 [hit_*], page 234

hit_distortion_xy *values*: floating point numbers; *default*: `0.0`; See Section 9.2.3 [hit_*], page 234

hit_distortion_yx *values*: floating point numbers; *default*: `0.0`; See Section 9.2.3 [hit_*], page 234

hit_distortion_yy *values*: floating point numbers; *default*: `1.0`; See Section 9.2.3 [hit_*], page 234

Messages: none
Action: none
Variants:


st_flash:

9.5.23 st_flat

A flat gypsum stone with many variants and features.

Besides the standard features of a movable, hollow or breakable stone the flat stone provides some very special features and variant transformations.

Movable and breakable flat stones will fall into Section 7.4.1 [fl_abyss], page 166. But just the movable variant will fall into Section 7.4.13 [fl_water], page 178, and Section 7.4.11 [fl_swamp], page 177.

A laser beam will shatter a breakable variant. Further on it transforms a plain flat stone, and just this variant, into a cracked variant, which is visually distinguishable by small cracks. But further laser light will not break a cracked variant. Ignitions and explosions will shatter breakable, cracked and movable variants. An actor with a revealed Section 8.3.17 [it_hammer], page 196, is able to shatter both the breakable and the cracked variant. Note that the visually indistinguishable Section 9.5.9 [st_break], page 250_laser breaks on a laser hit, too, but without being breakable by actors.

An actor with a revealed Section 8.3.20 [it_pencil], page 198, will mark a plain or movable variant as burnable what is hinted for the player by a fire symbol on the flat stone surface. A burnable flat stone burns on fire, but just the immovable, burnable variant reacts on heating by self destruction. All burnable variants can be cleaned by an actor hit with an Section 8.3.5 [it_brush], page 188. The fire symbol vanishes and the stone does not longer react on fire and heating.

Last but not least an Section 9.5.6 [st_boulder], page 246, hitting a plain or hollow variant of the flat stone toggles the '`hollow`' attribute twice within a short period. The time is sufficient for a fast actor to pass an otherwise solid plain flat stone. By proper fast redirection of the boulder a user can enforce permanent changes of the hollow state.

Attributes:

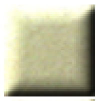
hollow *values*: `true`, `false`; *default*: `false`; *access*: read only See Section 9.2.4 [hollow], page 235

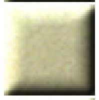
movable *values*: `true`, `false`; *default*: `false`; *access*: read only See Section 9.2.6 [movable], page 235

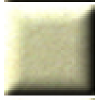
breakable *values*: `true`, `false`; *default*: `false`; *access*: read only See Section 9.2.1 [breakable], page 234

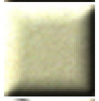
burnable *values*: `true`, `false`; *default*: `false`; *access*: read only See Section 7.2.2 [burnable], page 149

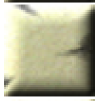
Messages: none
Action: none
Variants:

**st_flat**:

**st_flat_hollow**: hollow=`true`

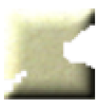
**st_flat_movable**: movable=`"true"`

**st_flat_breakable**: breakable=`"true"`

**st_flat_cracked**:

st_flat_burnable: burnable=`"true"`

st_flat_moveburnable: movable=`"true"`, burnable=`"true"`

**st_flat_breaking**: breakable=`"true"`

9.5.24 st_floppy

A switch that is activated by insertion of an Section 8.3.15 [it_floppy], page 195. Just actors assigned to a player can insert a floppy out of their item inventory by hitting the floppy switch with a floppy being the first item.

On a second hit the switch is deactivated and the inserted floppy is returned to the player's inventory.

Floppy stones are often used as openers for an adjacent Section 9.5.20 [st_door], page 258, that is declared as its '`target`'. But there is the inherent danger that an actor passing the door accidentially hits the neighboring floppy stone, causing the floppy to be pulled out again and the door to be closed immediately. Of couse this would shatter any Section 10.2.4 [ac_marble], page 325, or Section 10.2.5 [ac_pearl], page 326. But a '`secure`' floppy stone checks that the hitting actor is not positioned on one of the floppy stone's target positions. It refuses any actions caused by such critical hits. Note that in case the target is a callback function that closes the adjacent door, there will be still no protection. A floppy stone with '`secure`' value '`false`' would accept any hits and shatter marbles as it has been standard on older Enigma releases and is still in modes besides Enigma.

Attributes:

state, *values*: `ON`, `OFF`; *default*: `OFF`; See Section 6.1.2 [state], page 125
Current activity state of the floppy stone.

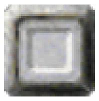
secure *values*: `true`, `false`; *default*: `true`
Protect actors on target positions by neglecting their hits.

Messages:

signal See Section 6.2.3 [signal], page 130
Switches on at value '`1`', and off at value '`0`'.

on See Section 6.2.4 [on], page 130
off See Section 6.2.5 [off], page 130

Action: See Section 6.1.3 [target], page 126, See Section 6.1.4 [action], page 126
Variants:


st_floppy with state=`OFF`

st_floppy with state=`ON`

9.5.25 st_fourswitch

A switch that points into one of the four orientations and turning on every switching event. The most common event is an actor hitting this stone. But Section 9.5.6 [st_boulder], page 246, will trigger this switch, too. Of course other objects can send messages on actions to make this switch turning.

When turning its pointer on a switching event it performs the action given by the '`action/target`'-pair. This can be either a common pair or a state/orientation dependent pair allowing you to issue different messages dependent on the pointing orientation.

Attributes:

state, *values*: `NORTH`, `EAST`, `SOUTH`, `WEST`; *default*: `NORTH` See Section 6.1.2 [state], page 125

counterclock *values*: `true`, `false`; *default*: `false`
The standard turning direction is clockwise. Use this attribute to revert the direction.

inverse See Section 6.1.7 [inverse], page 127
Note that the action value is inverted in its boolean interpretation. This means that an inverted action value is *not* the reverse orientation and should not be used as an orientation value at all.

Messages:

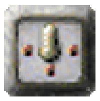
signal See Section 6.2.3 [signal], page 130
Note that the fourswitch reacts just on value `1`. Values of `0` are simply ignored. Use message toggle if you need turns on any message value.

toggle See Section 6.2.1 [toggle], page 129
Note that a toggle turns the fourswitch independent of a message value.

Action: See Section 6.1.3 [target], page 126, See Section 6.1.4 [action], page 126
Performs an action on each turn. If just a pair of global '`target/action`' attributes are given, the action message is sent to the target with a value of the new orientation. This value suits any message of the target that expects an orientation value, and the Section 6.2.3 [signal], page 130, message, that translates the orientation value to a 1 for '`NORTH`', '`SOUTH`' and a 0 for '`EAST`', '`WEST`'.

If state dependent target/action pairs are given instead, namely '`target_0/action_0`' for the state '`WEST`',... , '`target_3/action_3`' for the state '`NORTH`', two actions will be performed: first for the state representing the old orientation the given action messages will be sent with a value of 0, then for the state representing the new orientation the given action messages will be sent with a value of 1. This allows you to switch on and off alternative sources by a fourswitch.

Variants:


st_fourswitch

9.5.26 st_ghost

An invisible stone that transforms into a visible stone on actor hits with properly revealed tools.

Similar to Section 9.5.39 [st_magic], page 276, this stone does transform to another kind, but it is initially always invisible, what gave it its name. Invisibility is not equal to laser transparency. In fact one flavor of this ghost stone is not laser transparent. And invisibility does not mean that an invisible actor can pass a ghost stone. (see Section 9.6.1 [Transparent Stones], page 317)

The ghost stone transforms to another stone of the kind given by its attribute '`flavor`'. The tool necessary to cause this transformation depends on the flavor.

The flavor `"purplemarble"` transforms to an Section 9.3.14 [st_purplemarble], page 238, on a hit with a revealed Section 8.3.5 [it_brush], page 188. This flavor is not laser transparent.

The flavor `"greenbrown"` transforms to an Section 9.5.28 [st_greenbrown], page 267, on a hit with a revealed Section 8.3.19 [it_magicwand], page 197.

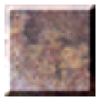
The flavor `"break"` transforms to an Section 9.5.9 [st_break], page 250, of variant '`st_break_oxydc`' on a hit with a revealed Section 8.3.5 [it_brush], page 188.

Attributes:

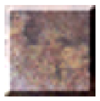
flavor *values*: `"purplemarble"`, `"greenbrown"`, `"break"`; *default*: `"purplemarble"`; *access*: read only

Messages: none
Action: none
Variants:

st_ghost: flavor=`"purplemarble"`

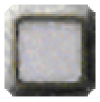


st_ghost_purplemarble: flavor=`"purplemarble"`



st_ghost_greenbrown: flavor=`"greenbrown"`

st_ghost_break: flavor=`"break"`



9.5.27 st_grate

Hovering metal grate in different flavors that let all actors pass but block stones from moving over a grid position.

The different flavors are just for decorative purposes, but `"cross"` variant looks identical to an open Section 9.5.20 [st_door], page 258, of flavor `"a"`, whereas `"framed"` variant looks identical to an open Section 9.5.20 [st_door], page 258, of flavor `"b"`.

In contrast to opened doors grates do bounce actors that are flying due to a jump.

As a hovering stone grates do not press Section 8.4.18 [it_trigger], page 226s and let laser light pass. Grates allow Section 13.2.2 [Flood Spreading], page 390, and Section 13.2.3 [Fire Spreading], page 392, too.

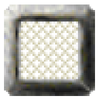
Attributes:

flavor	*values*: `"cross"`, `"framed"`; *default*: `"cross"`

Messages: none
Action: none
Variants:

st_grate: flavor=`"cross"`

st_grate_cross: flavor=`"cross"`


st_grate_framed: flavor=`"framed"`

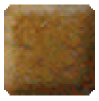
9.5.28 st_greenbrown

A mainly brown stone that is just a standard stone besides the fact that it can originate from two other objects.

On one hand an Section 8.3.26 [it_seed], page 203, of flavor `"fake"` will grow to a standard, unmovable greenbrown. Just for level initialization purpose you can even set a variant '`st_greenbrown_growing`' due to the Section 4.4.2 [Snapshot Principle], page 58.

On the other hand a Section 9.5.26 [st_ghost], page 265, of flavor `"greenbrown"` will transform to standard, unmovable greenbrown on an actor hit with a revealed Section 8.3.19 [it_magicwand], page 197.

Variants:


st_greenbrown

st_greenbrown_hollow

st_greenbrown_movable

st_greenbrown_growing

9.5.29 st_ice

A block of ice is a movable stone that freezes some items when being pushed over them. Of course a floor of Section 7.4.13 [fl_water], page 178, will freeze, too, when ice is being pushed over it. But a block of ice can be destroyed by explosions and by heating fire leaving either Section 7.4.6 [fl_ice], page 172, or Section 7.4.13 [fl_water], page 178.

When an ice block without frozen item is pushed onto a grid with a Section 8.2.2 [freezable], page 183, item, the ice will freeze the item and will move it beneath itself on subsequent pushes. All items that the user can carry in his inventory are Section 8.2.2 [freezable], page 183, and even some Section 8.4 [Static Items], page 209, like Section 8.4.10 [it_magnet], page 218, Section 8.4.14 [it_springboard], page 223, etc. But a few items react in a special manner when an ice block is pushed onto them:

- Section 8.4.15 [it_squashed], page 224, and Section 8.4.3 [it_burnable], page 212, with the exception of '`it_burnable_oil`', dissolve to nothing.
- Section 8.4.4 [it_crack], page 213, will vanish as the ice is putty for the cracked floors
- Section 8.3.26 [it_seed], page 203, will not start growing, even though the ice is pushed as a solid stone on top.
- Section 8.4.2 [it_bomb], page 211, will explode and destroy the ice block as well as the floor.
- Section 8.3.11 [it_dynamite], page 192, is very special - a burning dynamite gets extinguished by an ice block and becomes frozen in its idle state.

But what happens when an ice block with a frozen item gets pushed onto a grid with another item? The stronger item wins and survives beneath the ice block on the new position while the weaker item will be killed. The sequence from weak to strong is quite simple:

- static items that get anyway wiped out by an ice block
- Section 8.3 [Liftable Items], page 184,
- Section 8.2.4 [portable], page 184, items that are not Section 8.2.3 [liftable], page 184,
- Section 8.2.2 [freezable], page 183, items that are not Section 8.2.4 [portable], page 184,
- Section 8.4 [Static Items], page 209, that are not Section 8.2.2 [freezable], page 183,

When the two items are of the same category the already frozen item wins. This last rule ensures that the user can not free frozen items by dropping a liftable item out of his inventory in front of an ice block before pushing it.

An ice block looks like a bluish version of Section 9.5.54 [st_rawglass], page 298. But it has just one feature in common. It is transparent to laser light. Of course you can not freeze laser beams, even though they are implemented in the item layer. Laser light will interact even with frozen items and can ignite Section 8.3.11 [it_dynamite], page 192, or Section 8.4.2 [it_bomb], page 211. Even though being light transparent invisible actors can not pass it (see Section 9.6.1 [Transparent Stones], page 317).

Ice blocks shatter on nearby Section 8.4.2 [it_bomb], page 211, and Section 8.3.11 [it_dynamite], page 192, explosions and on Section 11.1.1 [ot_cannonball], page 330, hits. The ice will spread to the four direct neighboring grid positions and will cover these and the originating position with Section 7.4.6 [fl_ice], page 172. Just Section 7.4.1 [fl_abyss], page 166, will not be covered by this ice floor and remains unchanged. Thus an exploding bomb leaves an Section 7.4.1 [fl_abyss], page 166, at its position, even when an ice blocks shatters nearby.

A fire starting to burn on a direct neighbor position will eventually melt the ice block by its Section 13.2.4 [Heat-Transformation], page 394. The ice will melt to an Section 7.4.13 [fl_water], page 178. Just in case the ice block melts over an Section 7.4.1 [fl_abyss], page 166, the floor remains unchanged. The ice heating is no secure feature, as the heat burst occurs just once for each fire. Thus a user may be able to push an ice block aside a fire without heat transformation. Furtheron the melting takes time. Any intermediate nearby explosion can still shatter the melting ice block.

Messages:

ignite See Section 6.2.8 [ignite], page 131
Shatter the ice block.

heat See Section 6.2.9 [heat], page 131
Melt the ice block

Variants:

st_ice

9.5.30 st_inkwell

The inkwell stone can recolor marbles. The color change on the marble is instant. The following transformations are possible, each transformation is reversible:

```
st_inkwell_empty + ac_marble_black -> st_inkwell_black + ac_marble_glass
st_inkwell_black + ac_marble_glass -> st_inkwell_empty + ac_marble_black
st_inkwell_empty + ac_marble_white -> st_inkwell_white + ac_marble_glass
st_inkwell_white + ac_marble_glass -> st_inkwell_empty + ac_marble_white
```

In particular, a colored marble will not tranform if it touches a full `st_inkwell`; and a glass marble will not transform if it touches an empty `st_inkwell`. If you want to transform a black marble into a white one or vice versa, you will need two `st_inkwells`.

Please note that inkwell stones will recolor Section 10.2.5 [ac_pearl], page 326, as well, as soon as they are introduced to Enigma. As of now, an error will be shown when Section 10.2.5 [ac_pearl], page 326, touches an inkwell stone.

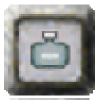
Attributes:

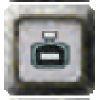
state *values*: `INKWELL_BLACK`, `INKWELL_EMPTY`, `INKWELL_WHITE`; *default*: `INKWELL_EMPTY`

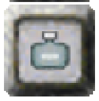
Messages:

none

Variants:


st_inkwell


st_inkwell_black


st_inkwell_empty

st_inkwell_white

9.5.31 st_jamb

A colored door jamb that allows coupled opening and closing on adjacent Section 9.5.20 [st_door], page 258s. Especially doors of flavor "d" can be opened by proper colored actors by door knocking.

The stone looks like 4 brown door jambs each with a colored ball on top. It fits to the 2 faced "d" variant of Section 9.5.20 [st_door], page 258. These doors can be configured to send the message "hit" to the adjacent jambs as their targets. Whenever an actor knocks the door, the jamb receives the message and checks the actor for matching color. On success it sends opening signals to the door being knocked and to a door being located on the opposite side of the jamb. Additionally doors located on the remaining two adjacent positions of the jamb will receive a closing signal. E.g.:

```
ti["n"] = {"st_door_d", "north", target="jamb", action="hit"}
ti["e"] = {"st_door_d", "east", target="jamb", action="hit"}
ti["s"] = {"st_door_d", "south", target="jamb", action="hit"}
ti["w"] = {"st_door_d", "west", target="jamb", action="hit"}
ti["J"] = {"st_jamb", "jamb"}
ti["@"] = {"st_marble"}
wo(ti, " ", {
  " n ",
  "wJe",
  " s@"
}
```

The black marble touching the east door will open the east and the west door, and will close the north and south door at the same time. The black marble touching the south door will open the south and the north door, and will close the west and east door.

Attributes:

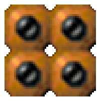
color *values*: `BLACK`, `WHITE`; *default*: `BLACK`

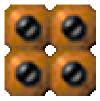
Messages:

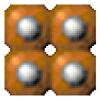
hit The message value must be an object reference of an actor. The color of the actor must match the jamb color to cause an action. The sender's position must either match the x or the y coordinate of the jamb, too.

signal See Section 6.2.3 [signal], page 130
This message is just kept for backward compatibility issues. Do not use it in new API levels as it depends on other internal attributes not set for new API levels.

Action: See Section 6.1.3 [target], page 126, See Section 6.1.4 [action], page 126
Variants:

 **st_jamb**: color=`BLACK`

 **st_jamb_black**: color=`BLACK`

 **st_jamb_white**: color=`WHITE`

9.5.32 st_key

A switch that is activated by insertion of an Section 8.3.18 [it_key], page 196. Just actors assigned to a player can insert a key out of their item inventory by hitting the key switch with a key being the first item. Just keys with a matching '`code`' are accepted.

On a second hit the switch is deactivated and the inserted key is returned to the player's inventory.

Key stones are often used as openers for an adjacent Section 9.5.20 [st_door], page 258, that is declared as its '`target`'. But there is the inherent danger that an actor passing the door accidentially hits the neighboring key stone, causing the key to be pulled out again and the door to be closed immediately. Of couse this would shatter any Section 10.2.4 [ac_marble], page 325, or Section 10.2.5 [ac_pearl], page 326. But a '`secure`' key stone checks that the hitting actor is not positioned on one of the key stones target positions. It refuses any actions caused by such critical hits. Note that in case the target is a callback function that closes the adjacent door, there will be still no protection. A key stone with '`secure`' value '`false`' would accept any hits and shatter marbles as it has been standard on older Enigma releases and is still in modes besides Enigma.

Usually the '`code`' of the key stone is not visually unveiled. But if you set '`invisible`' to the value '`false`' the code becomes visible for number code values '`1`' to '`8`'. This helps the user to distinguish the stones and to assign the correct Section 8.3.18 [it_key], page 196, when multiple instances are present.

An '`invisible`' key stone reveals its code when a matching, unveiled Section 8.3.18 [it_key], page 196, gets inserted.

Attributes:

state, *values*: `ON`, `OFF`; *default*: `OFF`; See Section 6.1.2 [state], page 125
Current activity state of the key stone.

code, *values*: number or string; *default*: `1`:
The code that is required to activate this switch.

secure *values*: `true`, `false`; *default*: `true`
Protect actors on target positions by neglecting their hits.

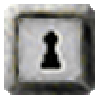
invisible *values*: `true`, `false`; *default*: `true`
A visible key stone unveils its '`code`' by a color spot.

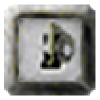
Messages:

signal See Section 6.2.3 [signal], page 130
Switches on at value '`1`', and off at values '`0`'.

on See Section 6.2.4 [on], page 130
off See Section 6.2.5 [off], page 130

Action: See Section 6.1.3 [target], page 126, See Section 6.1.4 [action], page 126
Variants:


st_key with state=`OFF`


st_key with state=`ON`

9.5.33 st_knight

A sword bearing knight stone that shatters all marbles that hit it, as long as they are not protected by an activated Section 8.3.32 [it_umbrella], page 207, or wield an Section 8.3.31 [it_sword], page 206.

By hitting '`st_knight`' with an Section 8.3.31 [it_sword], page 206, four times, the knight stone spits out a cheeky remark and can be passed thereafter, even without a sword.

A beaten knight stone is transparent to laser light.

Attributes:

state, *values*: `0` to `4`; *default*: `0`; *access*: `read only` See Section 6.1.2 [state], page 125

Current hit count of the knight stone. Starting uninjured at state '`0`' the knight is beaten after 4 hits.

Messages: none
Action: none
Variants:

st_knight

9.5.34 st_laser

The laser stone is the only object that is capable of emitting light beams. Per default laser stones are switched off. The '`state`' attribute represents the activity of the laser and can be set initially to '`ON`'. A laser is orientated to one direction into which the light will be emitted.

Lasers have a latency that protect them from infinite fast switching cycles. This allows you to toggle a laser with an Section 9.5.36 [st_laserswitch], page 274, that is illuminated by the laser itself. During the latency period pending switch requests will be registered but will be executed with a certain small delay. Note that several pending requests may even neutralize and revoke each other.

An initially switched on laser will not cause actions with its light beam due to the Section 4.4.2 [Snapshot Principle], page 58. If you have need of the actions you may switch on the laser by a message in the '`postinit`' function (See Section 4.4.3 [Level Initialization], page 59). E.g. a flickering laser caused by a laser that illuminates a Section 9.5.36 [st_laserswitch], page 274, which toggles the laser needs to be switched on by a message.

Attributes:

state, *values*: `ON`, `OFF`; *default*: `OFF` See Section 6.1.2 [state], page 125

orientation, *values*: `NORTH`, `EAST`, `SOUTH`, `WEST`; *default*: `NORTH`
: The orientation of the laser. It determines the direction that the laser will emit light if it is switched on.

counterclock *values*: `true`, `false`; *default*: `false`
: The standard turning direction is clockwise. Use this attribute to revert the direction.

Messages:

signal See Section 6.2.3 [signal], page 130
: Switch the laser on at value '`1`' and off at value '`0`'.

on See Section 6.2.4 [on], page 130

off See Section 6.2.5 [off], page 130

turn Turn orientation in turning direction as defined by attribute '`counterclock`'.

turnback Turn orientation in opposite turning direction as defined by attribute '`counterclock`'.

Action: none

Variants:

st_laser_w: orientation = `WEST`, state = `OFF`

st_laser_w: orientation = `WEST`, state = `ON`

st_laser_s: orientation = `SOUTH`, state = `OFF`

st_laser_s: orientation = `SOUTH`, state = `ON`

st_laser_e: orientation = `EAST`, state = `OFF`

st_laser_e: orientation = `EAST`, state = `ON`

st_laser_n: orientation = `NORTH`, state = `OFF`

st_laser_n: orientation = `NORTH`, state = `ON`

9.5.35 st_laserflop

A switch that is triggered by actor hits and laser light. It switches instantly to state '`ON`' and when it is no longer illuminated it switches back to state '`OFF`' after a given '`interval`'. Repetitive actor hits and continuing laser light will prolong the '`ON`' state until a trailing '`interval`' after the last hit has been expired. A similar object without light sensitiveness is the Section 9.5.42 [st_monoflop], page 282.

The single state cycle, called monoflop, can be initiated by '`on`' and '`signal`' messages. But an activated monoflop cannot be stopped by messages or state setting.

At initialization a laserflop that is exposed to laser light will start in state '`ON`' without sending actions due to the Section 4.4.2 [Snapshot Principle], page 58.

A laserflop that is moved or swapped in or out of a laser beam will act on the light change with proper actions.

Attributes:

state, *values*: `ON`, `OFF`; *default*: `OFF`; See Section 6.1.2 [state], page 125
Represents the activity state. The state of a new object can be set, but an active laserflop cannot be set to state '`OFF`'.

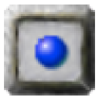
interval *values*: positive number; *default*: `1.8`
Number of seconds to return to state '`OFF`' after the last hit.

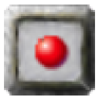
Messages:

signal See Section 6.2.3 [signal], page 130
Switches on at value '`1`'. A value of '`0`' is ignored.

on See Section 6.2.4 [on], page 130
Switches the laserflop on like on an actor hit.

Action: See Section 6.1.3 [target], page 126, See Section 6.1.4 [action], page 126
Variants:


st_laserflop: state = `OFF`


st_laserflop: state = `ON`

9.5.36 st_laserswitch

A switch that is exclusively triggered by laser light. It switches instantly to state '`ON`' when a laser beam hits the stone from any direction. It switches instantly back to state '`OFF`' when it is no longer illuminated.

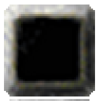
There is no way to set the state of this stone manually. But the state can nevertheless be read. At initialization a laserswitch that is exposed to laser light will start in state '`ON`' without sending actions due to the Section 4.4.2 [Snapshot Principle], page 58.

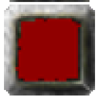
A laserswitch that is moved or swapped in or out of a laser beam will act on the light change with proper actions.

Attributes:

state, *values*: `ON`, `OFF`; *default*: `OFF`; *access*: `read only` See Section 6.1.2 [state], page 125

Messages: none
Action: See Section 6.1.3 [target], page 126, See Section 6.1.4 [action], page 126


st_laserswitch: state = `OFF`


st_laserswitch: state = `ON`

9.5.37 st_lightglass

A metal framed transparent glass stone. It exists in static, movable and hollow variants and is by its very nature transparent to laser light. Like other Section 9.6.1 [Transparent Stones], page 317, it is passable for invisible actors as long as it is not '`movable`'.

A Section 9.5.39 [st_magic], page 276, of variant `st_magic_oxyda` transforms on actor hits to a movable lightglass stone

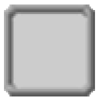
Attributes:

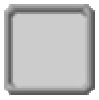
hollow *values*: `true`, `false`; *default*: `false`; *access*: read only See Section 9.2.4 [hollow], page 235

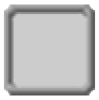
movable *values*: `true`, `false`; *default*: `false`; *access*: read only See Section 9.2.6 [movable], page 235

Messages: none

Variants:


st_lightglass: hollow = `false`, movable = `false`


st_lightglass_hollow: hollow = `true`, movable = `false`


st_lightglass_movable: hollow = `false`, movable = `true`

9.5.38 st_lightpassenger

The light passenger skates on a laser beam, and may push up to one movable stone in front of it. Opposing laser beams are ignored. When another laser beam crosses the actual laser beam on which the passenger skates, the passenger switches beams. If it is initially lighted by two rectangular beams, one of them will be chosen by random. The light passenger's skating ability can be turned off and on.

When a stone is in its way, the passenger sends an impulse to the blocking stone, which may move it, but it may also have other effects; e.g., a turnstile turns around and an impulse-stone starts pulsing, but it does not open oxyds (this is intended).

The light passenger can't be pushed by actors, but, e.g., by Section 9.5.61 [st_stoneimpulse], page 304.

The speed of the light passenger can be changed with the '`interval`'-attribute (default 50 ms, which is quite fast) and may include the floor friction and local gradient via '`friction`' and '`gradient`'. The resulting interval results as

```
interval  =  base * (1 + stone_friction * floor_friction) / (1 + stone_gradient * floo
```

with '`base`' the value of the '`interval`'-attribute, '`floor_friction`' the friction of the floor below the light passenger, and '`floor_gradient`' the parallel part of the force of the floor, i.e., the sum of gradient-force and `force_x/y`-attributes.

The light passenger can be switched on and off by messages (see below), and appears as '`st_darkglass`' when inactive. A player with an Section 8.3.16 [it_glasses], page 195, in his inventory that includes the '`SPOT_LIGHTPASSENGER`' feature is able to distinguish the switched off lightpassenger from an '`st_darkglass`'. The variant '`st_lightpassenger_off`' is deactivated from the beginning. A lightpassenger that moves onto an Section 8.4.5 [it_cross], page 215, switches off immediately. A switched off lightpassenger can be switched on by an actor hit with a revealed Section 8.3.5 [it_brush], page 188, in the inventory. Such a touch with a brush does wipe out a cross beneath the lightpassenger, too.

An Section 9.5.6 [st_boulder], page 246, hitting a lightpassenger toggles the lightpassenger's state for a short period.

When an active '`st_lightpassenger`' is trapped between exactly two opposing light beams or light beams from all four directions, it starts blinking. In this state, it can be destroyed with Section 8.3.17 [it_hammer], page 196.

Attributes:

state, *values*: `ON`, `OFF`; *default*: `ON`; See Section 6.1.2 [state], page 125
Represents the activity state.

interval *values*: positive number; *default*: `0.05`
The base interval for movements.

friction *values*: positive number; *default*: `0.0`
Stone friction of the speed of the light passenger.

gradient *values*: positive number; *default*: `0.0`
Stone gradient of the speed of the light passenger.

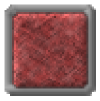
Messages:

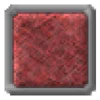
signal See Section 6.2.3 [signal], page 130
Switches on at value '`1`'. A value of '`0`' is ignored.

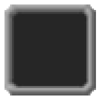
on See Section 6.2.4 [on], page 130
Switch the lightpassenger on.

off See Section 6.2.5 [off], page 130
Switch the lightpassenger off.

Variants:


st_lightpassenger: state = `ON`


st_lightpassenger_on: state = `ON`


st_lightpassenger_off: state = `OFF`

9.5.39 st_magic

A stone that mimics one stone, but transforms on actor hits into another stone.

Like Section 9.5.21 [st_fake], page 260, this stone does initially look like another stone of a kind given by the attribute '`flavor`'. But on an actor hit with or without tool it transforms to another stone, which provides its own set of features.

The flavor `"brick"` just transforms on a hit with a revealed Section 8.3.19 [it_magicwand], page 197, into a static Section 9.5.54 [st_rawglass], page 298.

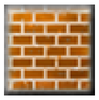
The flavor `"oxyda"` transforms on any hit into a movable Section 9.5.37 [st_lightglass], page 275.

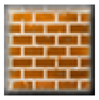
The flavor `"oxydc"` transforms on any hit into a movable Section 9.5.54 [st_rawglass], page 298.

Attributes:

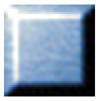
flavor *values*: `"brick"`, `"oxyda"`, `"oxydc"`; *default*: `"brick"`; *access*: read only

Messages: none
Action: none
Variants:


st_magic: flavor=`"brick"`


st_magic_brick: flavor=`"brick"`

st_magic_oxyda: flavor=`"oxyda"`


st_magic_oxydc: flavor=`"oxydc"`

9.5.40 st_mail

When hit by an actor, a mail stone takes the first item out of the player's inventory and drops it at its exit, or the exit of the appending Section 8.3.22 [it_pipe], page 199. If this position is blocked (e.g., by another item), no item is taken from inventory. The Section 8.3.4 [it_brake], page 187, is the only item that gets delivered even if another item is positioned at the end of the pipe as it emerges the pipe as an Section 9.5.8 [st_brake], page 249, stone. An Section 8.3.22 [it_pipe], page 199, end piece with just one fitting connection closes a mail pipe completely, rejecting any item insertion.

Attributes:

orientation, *values*: `NORTH`, `EAST`, `SOUTH`, `WEST`; *default*: `NORTH`
The orientation of the mail stone. It determines the neighbor's grid position onto which the item will be dropped, or where the pipe starts.

Messages: none
Action: none
Variants:

st_mail: orientation = `NORTH`

st_mail_w: orientation = `WEST`

st_mail_s: orientation = `SOUTH`

st_mail_e: orientation = `EAST`

st_mail_n: orientation = `NORTH`

9.5.41 st_mirror

Mirror stones redirect and fork laser beams. They exist in different shapes. You can set the shape by the attribute '`flavor`' or by using the appropriate subkind. There are two planar versions called '`slab`' and '`sheets`', and a '`triangle`' version.

The mirror panes can either be non-transparent or semi-transparent. Even though you set this feature with the attribute '`transparent`' you should be aware that even with a value of '`true`' the mirror is not fully transparent. E.g. a '`slab`' mirror will block any laser light that is parallel to its shape as the short ends are no mirrors at all. For this reason we provide the second planar version called '`sheets`', which lets light parallel to its sheets pass.

Mirrors hit by an actor or impulsed by an Section 9.5.61 [st_stoneimpulse], page 304, will move if their attribute '`movable`' is set to true. Mirrors that are not movable will differ slightly in a darker color.

Mirrors hit or just touched will turn their mirror panes by 90 degrees. The standard turning direction is clockwise. But this standard can be changed by the attribute '`counterclock`'. An Section 9.5.6 [st_boulder], page 246, hitting a mirror will turn it in its standard direction, too.

A mirror can be turned into the opposite direction either by a message '`turnback`' or by an actor with a revealed Section 8.3.34 [it_wrench], page 208, in its inventory.

Mirrors moved by stone pushing impulses issued by Section 8.3.23 [it_puller], page 200, Section 9.5.61 [st_stoneimpulse], page 304,... or send by Section 11.1.3 [ot_wire], page 331, will move without being turned.

Attributes:

flavor *values*: `"slab"`, `"sheets"`, `"triangle"`; *default*: `"slab"`
Mirror panes either set up as a triangle or as a side opaque slab or as a mandatory semi-transparent pair of sheets.

state, *values*: `NORTH`, `EAST`, `SOUTH`, `WEST`; *default*: `NORTH`; See Section 6.1.2 [state], page 125
The orientation of the mirror. For a triangular mirror it is the triangle's pointing direction. For a planar mirror it is the reflection direction of an incoming northbound beam.

orientation, *values*: `NORTH`, `EAST`, `SOUTH`, `WEST`, `RANDOMDIR`; *default*: `NORTH`
The orientation of the mirror. For a triangular mirror it is the triangle's pointing direction. For a planar mirror it is the reflection direction of an incoming northbound beam. The value `RANDOMDIR` is just evaluated when the mirror is being set. From this point of time the mirror will report a random orientation out of the other 4 real orientations.

transparent *values*: `true`, `false`; *default*: `false`
Semitransparency of the mirror panes.

movable *values*: `true`, `false`; *default*: `false` See Section 9.2.6 [movable], page 235
Movability on actor hits and stone impulses.

counterclock *values*: `true`, `false`; *default*: `false`
The standard turning direction is clockwise. Use this attribute to revert the direction.

Messages:

orientate, *value type*: orientation
Change the orientation to the given orientation value. The Section 9.5.25 [st_fourswitch], page 264, provides a compatible action which allows you to set a mirror as target and this message as action.

turn Turn the orientation in turning direction as defined by attribute '`counterclock`'.

turnback Turn the orientation in opposite turning direction as defined by attribute '`counterclock`'.

signal See Section 6.2.3 [signal], page 130
Turn the orientation in turning direction as defined by attribute '`counterclock`' on value '`1`'. A value of '`0`' is ignored.

Action: none
Variants:

st_mirror_triangle: flavor=`triangle`, state = `NORTH`, transparent = `false`, movable = `false`

st_mirror_triangle: flavor=`triangle`, state = `NORTH`, transparent = `false`, movable = `true`

st_mirror_triangle: flavor=`triangle`, state = `EAST`, transparent = `false`, movable = `false`

st_mirror_triangle: flavor=`triangle`, state = `EAST`, transparent = `false`, movable = `true`

st_mirror_triangle: flavor=`triangle`, state = `SOUTH`, transparent = `false`, movable = `false`

st_mirror_triangle: flavor=`triangle`, state = `SOUTH`, transparent = `false`, movable = `true`

st_mirror_triangle: flavor=`triangle`, state = `WEST`, transparent = `false`, movable = `false`

st_mirror_triangle: flavor=`triangle`, state = `WEST`, transparent = `false`, movable = `true`

st_mirror_triangle: flavor=`triangle`, state = `NORTH`, transparent = `true`, movable = `false`

st_mirror_triangle: flavor=`triangle`, state = `NORTH`, transparent = `true`, movable = `true`

st_mirror_triangle: flavor=`triangle`, state = `EAST`, transparent = `true`, movable = `false`

st_mirror_triangle: flavor=`triangle`, state = `EAST`, transparent = `true`, movable = `true`

st_mirror_triangle: flavor=`triangle`, state = `SOUTH`, transparent = `true`, movable = `false`

st_mirror_triangle: flavor=`triangle`, state = `SOUTH`, transparent = `true`, movable = `true`

st_mirror_triangle: flavor=`triangle`, state = `WEST`, transparent = `true`, movable = `false`

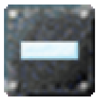
st_mirror_triangle: flavor=`triangle`, state = `WEST`, transparent = `true`, movable = `true`

st_mirror_slab: flavor=`slab`, state = `NORTH`, transparent = `false`, movable = `false`

st_mirror_slab: flavor=`slab`, state = `NORTH`, transparent = `false`, movable = `true`

st_mirror_slab: flavor=`slab`, state = `EAST`, transparent = `false`, movable = `false`

st_mirror_slab: flavor=`slab`, state = `EAST`, transparent = `false`, movable = `true`


st_mirror_slab: flavor=slab, state = SOUTH, transparent = false, movable = false

st_mirror_slab: flavor=slab, state = SOUTH, transparent = false, movable = true

st_mirror_slab: flavor=slab, state = WEST, transparent = false, movable = false

st_mirror_slab: flavor=slab, state = WEST, transparent = false, movable = true

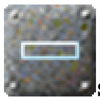
st_mirror_slab: flavor=slab, state = NORTH, transparent = true, movable = false

st_mirror_slab: flavor=slab, state = NORTH, transparent = true, movable = true

st_mirror_slab: flavor=slab, state = EAST, transparent = true, movable = false

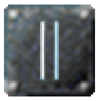
st_mirror_slab: flavor=slab, state = EAST, transparent = true, movable = true

st_mirror_slab: flavor=slab, state = SOUTH, transparent = true, movable = false


st_mirror_slab: flavor=slab, state = SOUTH, transparent = true, movable = true

st_mirror_slab: flavor=slab, state = WEST, transparent = true, movable = false

st_mirror_slab: flavor=slab, state = WEST, transparent = true, movable = true


st_mirror_sheets: flavor=sheets, state = NORTH, transparent = true, movable = false

st_mirror_sheets: flavor=sheets, state = NORTH, transparent = true, movable = true

st_mirror_sheets: flavor=sheets, state = EAST, transparent = true, movable = false

st_mirror_sheets: flavor=sheets, state = EAST, transparent = true, movable = true

st_mirror_sheets: flavor=sheets, state = SOUTH, transparent = true, movable = false

st_mirror_sheets: flavor=sheets, state = SOUTH, transparent = true, movable = true

st_mirror_sheets: flavor=`sheets`, state = `WEST`, transparent = `true`, movable = `false`

st_mirror_sheets: flavor=`sheets`, state = `WEST`, transparent = `true`, movable = `true`

9.5.42 st_monoflop

A switch that is triggered by actor hits. It switches instantly to state '`ON`' and after a given '`interval`' back to state '`OFF`'. Repetitive actor hits will prolong the '`ON`' state until a trailing '`interval`' after the last hit has been expired. A switch similar to the monoflop is the Section 9.5.35 [st_laserflop], page 273, which is additionally light sensitive.

The single state cycle, called monoflop, can be initiated by '`on`' and '`signal`' messages. But an activated monoflop cannot be stopped by messages or state setting.

Attributes:

state, *values*: `ON`, `OFF`; *default*: `OFF`; See Section 6.1.2 [state], page 125
: Represents the activity state. The state of a new object can be set, but an active monoflop cannot be set to state '`OFF`'.

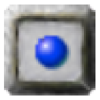
interval *values*: positive number; *default*: `1.8`
: Number of seconds to return to state '`OFF`' after the last hit.

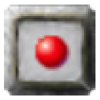
Messages:

signal See Section 6.2.3 [signal], page 130
: Switches on at value '`1`'. A values of '`0`' is ignored.

on See Section 6.2.4 [on], page 130
: Switch the monoflop on like on an actor hit.

Action: See Section 6.1.3 [target], page 126, See Section 6.1.4 [action], page 126
Variants:

 **st_monoflop**: state = `OFF`

 **st_monoflop**: state = `ON`

9.5.43 st_oneway

A stone with one special face, that allows actors just to pass from inside to outside but not vice versa. The other faces can generally be passed in both directions. As most times it is more important to be aware of the passages that are blocked, you may remember that the oneway's arrow points to the side that can not be entered.

Three variants of the oneway do exist. A neutral, green-grey colored one that lets any actor pass according to the above rules, and additionally a black and a white colored oneway. These last oneways will let pass only marbles of matching color. All other actors will reflect from all four sides.

All oneways can only be passed by actors moving on the floor. Jumping actors will bounce on every side.

The '`orientation`' of a neutral oneway can be flipped to the opposite direction by an actor hitting it with a revealed Section 8.3.19 [it_magicwand], page 197. All oneway variations will change their orientation on messages '`signal`' and '`flip`'.

Attributes:

state, *values*: `NORTH`, `EAST`, `SOUTH`, `WEST`; *default*: `NORTH` See Section 6.1.2 [state], page 125
The orientation of the oneway as shown by the arrow.

orientation, *values*: `NORTH`, `EAST`, `SOUTH`, `WEST`; *default*: `NORTH`
The orientation of the oneway as shown by the arrow.

color *values*: `nil`, `BLACK`, `WHITE`; *default*: `nil`
The color of the oneway that needs to match the actor's color to allow passing. The default '`nil`' color is a greengrey oneway that matches all actors, marbles of any color as well as all other actors.

Messages:

orientate, *value type*: orientation
Change the orientation to the given orientation value. The Section 9.5.25 [st_fourswitch], page 264, provides a compatible action which allows you to set a oneway as target and this message as action.

flip, Flip the orientation to the opposite direction.

signal See Section 6.2.3 [signal], page 130
Flip the orientation to the opposite direction.

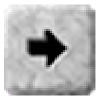
Action: none
Variants:

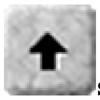
st_oneway: orientation = `EAST`

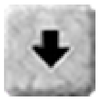
st_oneway: orientation = `NORTH`

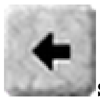
st_oneway: orientation = `SOUTH`

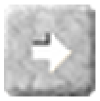
st_oneway: orientation = `WEST`


st_oneway_black: color = `BLACK`; orientation = `EAST`


st_oneway_black: color = `BLACK`; orientation = `NORTH`

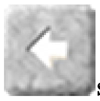

st_oneway_black: color = `BLACK`; orientation = `SOUTH`


st_oneway_black: color = `BLACK`; orientation = `WEST`


st_oneway_white: color = `WHITE`; orientation = `EAST`

st_oneway_white: color = `WHITE`; orientation = `NORTH`

st_oneway_white: color = `WHITE`; orientation = `SOUTH`


st_oneway_white: color = `WHITE`; orientation = `WEST`

9.5.44 st_oxyd

The main target stones of the game. Opening all regular oxyd stones is the standard goal of the existing Section 4.4.8 [Ending Conditions], page 61. Regular oxyds stones show a color spot when opening. Pairs of same colored stones have to be opened in sequence, otherwise the first one closes again.

Even though most levels make use of just a single pair of each color, there is no limit on a single color. If you like you can define 3 pairs of blue oxyds together with 2 yellow pairs. You do this by setting explicit '`oxydcolor`' attributes to the oxyds.

For standard levels the '`oxydcolor`' can be set to its default '`OXYD_AUTO`'. This causes an automatic coloring by pairs of colors in the standard color sequence.

There is no limit on the number of used oxyd pairs. There exist 12 different regular colors for oxyds. But per default just the first 8 colors will be assigned to '`OXYD_AUTO`' colored oxyds. The colors will repeat from the 9th pair giving the user the possibility to build arbitrary couples within a single color. With the world attribute Section 6.4.23 [MaxOxydColor], page 143, you can lower or increase this limit. By setting this attribute to '`OXYD_GREEN`' you can enforce the engine to assign just the first three colors. Be careful in usage of more than 8 colors as levels can get incredibly difficult.

The number of auto colored oxyds should usually be even as a single remaining oxyd of a color keeps a level from being solvable. In case of an uneven number one oxyd stone gets colored to '`OXYD_FAKE`' and does not participate in the stone opening procedure. But still you can set uneven number of oxyds of a given color if you do not use auto coloring but use explicit color values. Same thing happens if you delete a single oxyd during the running game. In both cases Enigma reacts with an error message by default. You can suppress this exception by setting Section 6.4.2 [AllowSingleOxyds], page 137, to `true`. In this case it is the author's responsibility to guarantee that the level can be solved.

Usually oxyds are shuffled by a '`wo:shuffleOxyd()`' statement after setting of all oxyds. All '`CLOSED`' oxyds that are not explicitly excluded by the '`noshuffle`' attribute take place in shuffling. But you can define arbitrary rules to limit and influence the shuffling process to guarantee solvability and fairness (see Section 5.13.11 [shuffleOxyd], page 114).

Oxyds are opened either by an actor hit, an additional laser beam, an Section 9.5.6 [st_boulder], page 246, triggering, an Section 11.1.1 [ot_cannonball], page 330, emitted from an Section 9.5.60 [st_spitter], page 302, or a message call. A single opened oxyd is in the state '`OPEN`'. If a matching second oxyd is opened both switch to the state '`OXYDPAIR`'. Note that this state can be requested, but it can not be set directly.

Single opened oxyds close on a not matching partner oxyd being opened and on '`close`' messages and state setting operations. But oxyds being part of an opened pair will not be closed this way.

All oxyds including pairs will close on the '`closeall`' messages that is issued by Section 9.5.53 [st_quake], page 297, and oxyds colored '`OXYD_QUAKE`' on actor hits.

Closed oxyds can have different looks. Their visual representation is defined by their '`flavor`'. Most flavors do hide the oxyd color in the closed state. Only flavor `"e"` starts with hidden color, but once opened returns to a closed image with a peep hole that lets the player still see the color.

For each flavor exists an identical looking simple stone: '`st_fake_oxyda`', '`st_fake_oxydb`', '`st_fake_oxydc`', '`st_fake_oxydd`', '`st_fake_oxyde`' (see Section 9.5.21 [st_fake], page 260). If you like an identical looking pseudo stone that takes part in the oxyd shuffling you can use an oxyd of color '`OXYD_FAKE`'.

During the game oxyds can be reshuffled. Just those oxyds that are still closed will take part in the new shuffle process. Oxyd shuffling rules will still be guaranteed for these partial in game reshuffles. It can be initiated either by a '`shuffle`' message that is send to any of the oxyd objects, or by usage of an oxyd of color '`OXYD_BOLD`'. If such a special oxyd is opened, e.g. by an actor hit, it shuffles all remaining oxyds including itself.

At initialization an oxyd that is exposed to laser light will start in state '`CLOSED`'. As it is the gaming target it is a certain exception to the Section 4.4.2 [Snapshot Principle], page 58.

An oxyd that is swapped in or out of a laser beam will act on the light change with proper actions.

Every opened oxyd causes an action call. The action call for an opened oxyd pair occurs just once when the second oxyd starts opening, whereas the bold and quake oxyd will perform the action after completion of their task and animation. Thus you are allowed to kill quake and bold oxyds within their action as long as you properly set Section 6.1.6 [safeaction], page 127, to `true`.

For a replacement of an opened pair of oxyd stones, what can be seen in the "opal" levels, the action call is not directly suitable, because the second oxyd did not yet show its matching color. Furtheron you would have to keep track of the oxyds to find the matching partner for the second oxyd. For this reason you can directly declare replacements that should be set when an oxyd pair is opened. The replacement takes place as soon as the second oxyd finishes the opening animation. Like the Section 9.5.62 [st_surprise], page 305, the oxyd allows you to set the '`selection`' attribute with tokens of strings. Every string needs either to be an Section 4.2.1 [Object Kind], page 49, or a tile key prefixed by an equal sign '`=`'.

```
ti["n"] = {"st_nil"}
ti["g"] = {"st_granite"}
ti["s"] = {"st_oxyd_e", selection={"=n", "=g"}}
```

The first token defines the replacement for the oxyd stone that has been opened first, the last token defines the replacement for the matching oxyd stone that has been opened afterwards. In case of a single token both oxyd stones are being replaced by equivalent stones.

The tile declarations referenced by a key may even contain objects besides stone. But you should make rare and proper usage of this feature.

The oxyd stone is killed by any replacement stone set to the grid position. If your selection does not resolve to a stone you may need to add `"st_nil"` to the replacement tile declaration.

Attributes:

state, *values*: `CLOSED`, `OPEN`, `OXYDPAIR`; *default*: `CLOSED` See Section 6.1.2 [state], page 125

flavor, *values*: `"a"`, `"b"`, `"c"`, `"d"`, `"e"`; *default*: `"b"`

The flavor only affects the visual representation of the stone. Mainly the closed state and the way of opening differ in the following way:

`"a"` bronze, pyramid like stone that opens like a flower
`"b"` black, flat stone that opens by a fade animation
`"c"` blue, flat stone that opens by a concentric animation
`"d"` dark blue, pyramid like stone that opens like a flower
`"e"` black, flat stone that provides a peep hole after closing

oxydcolor, *values*: `OXYD_AUTO`, `OXYD_FAKE`, `OXYD_QUAKE`, `OXYD_BOLD`, `OXYD_BLUE`, `OXYD_RED`, `OXYD_GREEN`, `OXYD_YELLOW`, `OXYD_CYAN`, `OXYD_PURPLE`, `OXYD_WHITE`, `OXYD_BLACK`, `OXYD_GRAY`, `OXYD_ORANGE`, `OXYD_PINE`, `OXYD_BROWN`; *default*: `OXYD_AUTO`

●	`OXYD_BLUE`	●	`OXYD_RED`	●	`OXYD_GREEN`	●	`OXYD_ YELLOW`
●	`OXYD_CYAN`	●	`OXYD_ PURPLE`	○	`OXYD_WHITE`	●	`OXYD_BI`
●	`OXYD_GRAY`	●	`OXYD_ ORANGE`	●	`OXYD_PINE`	●	`OXYD_BI`
●	`OXYD_BOLD`	●	`OXYD_QUAKE`				

noshuffle *values*: `true`, `false`; *default*: `false`

static *values*: `true`, `false`; *default*: `false`

Static oxyds are neither swappable nor pullable.

selection, *values*: tokens of stone kinds and tile keys; *default*: no replacement

Messages:

signal See Section 6.2.3 [signal], page 130

Try open at value ‘`1`’, and close at values ‘`0`’.

open See Section 6.2.6 [open], page 130

close See Section 6.2.7 [close], page 131

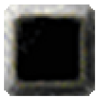
closeall Closes all opened oxyds if sent to any object instance.

peepall All closed oxyds of flavor `"e"` will show a peep hole if this message is sent to any oxyd object instance.

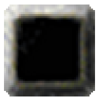
shuffle Reshuffles all closed oxyds if sent to any object instance.

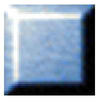
Action: See Section 6.1.3 [target], page 126, See Section 6.1.4 [action], page 126
Whenever a `CLOSED` oxyd gets opened an action with value `true` is performed. The action is performed directly after the oxyds own reaction on being opened, like checking gaming ending conditions, reshuffling or closing all oxyds, did finish. Additionally an action with value `false` is performed after an oxyd changes from an open state to `CLOSED`. Note that no action is performed on state changes form `OPEN` to `OXYDPAIR`.

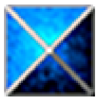
Variants:

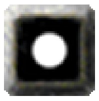

st_oxyd: flavor = `"b"`

st_oxyd_a: flavor = `"a"`


st_oxyd_b: flavor = `"b"`


st_oxyd_c: flavor = `"c"`


st_oxyd_d: flavor = `"d"`


st_oxyd_e: flavor = `"e"`

9.5.45 st_passage

A black or white colored stone of different shapes that lets pass only actors of matching color.

The shape is described by the attribute '`flavor`'. The shape does not affect the behaviour, but may be important for the visibility of actors and items beneath.

Passage stones react on '`signal`' and '`toggle`' messages and Section 9.5.6 [st_boulder], page 246, arriving on one of its sides. In both cases the passage stone recolors to the opposite color. In case of a boulder the recoloring is of a quite short period, as this stone recolors the passage twice. The period in between is long enough for an actor to pass or to redirect the boulder before sending the second recoloring message.

Attributes:

color *values*: `BLACK`, `WHITE`; *default*: `BLACK`
The color of the passage that determines which actors can pass.

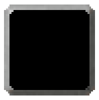
state, *values*: `BLACK`, `WHITE`; *default*: `BLACK` See Section 6.1.2 [state], page 125
The state is a synonym for color.

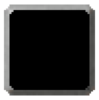
flavor *values*: `"square"`, `"slash"`, `"cross"`, `"frame"`; *default*: `"square"`
The passage shape.

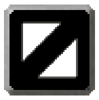
Messages:

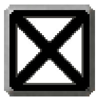
signal See Section 6.2.3 [signal], page 130
Switch color of the passage.

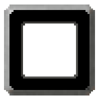
Action: none
Variants:

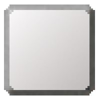

st_passage: color = `BLACK`, flavor = `"square"`

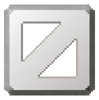

st_passage_black: color = `BLACK`, flavor = `"square"`

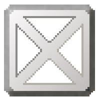

st_passage_black: color = `BLACK`, flavor = `"slash"`

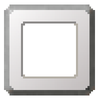

st_passage_black: color = `BLACK` - flavor = `"cross"`


st_passage_black: color = `BLACK` - flavor = `"frame"`


st_passage_white: color = `WHITE`, flavor = `"square"`


st_passage_white: color = `WHITE` - flavor = `"slash"`


st_passage_white: color = `WHITE` - flavor = `"cross"`


st_passage_white: color = `WHITE` - flavor = `"frame"`

9.5.46 st_pebble

This is the rock member of the rock-paper-scissors trio, the other two stones being Section 9.5.19 [st_document], page 258, and Section 9.5.58 [st_scissors], page 300. When `st_pebble` is touched, each `st_scissors` bordering it or being connected to it by a wire is destroyed. Similarly, when an `st_document` is touched, that borders or is connected to an `st_pebble`, the `st_pebble` will break.

Attributes: none
Messages: none
Action: none
Variants:

st_pebble

9.5.47 st_plaster

A sculptured gypsum stone that exists in various variations of basic stone attributes.

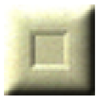
Unlike the similar looking Section 9.5.23 [st_flat], page 262, has no special features and behaves like a standard stone.

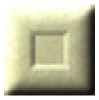
But it provides breakable variants. Like Section 9.5.9 [st_break], page 250, it is breakable by laser light, neighboring ignitions like those caused by an exploding Section 8.3.11 [it_dynamite], page 192, on a direct neighboring position or an exploding black Section 8.4.2 [it_bomb], page 211, on a diagonal neighboring position. It breaks on actor hits with a revealed Section 8.3.17 [it_hammer], page 196, too. But unlike Section 9.5.9 [st_break], page 250, it offers a variant that is breakable and movable at the same time. Of course a possible break supersedes a possible push condition.

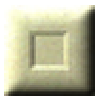
Attributes:

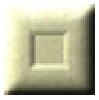
hollow *values*: `true`, `false`; *default*: `false`; *access*: read only See Section 9.2.4 [hollow], page 235
movable *values*: `true`, `false`; *default*: `false`; *access*: read only See Section 9.2.6 [movable], page 235
breakable *values*: `true`, `false`; *default*: `false`; *access*: read only See Section 9.2.1 [breakable], page 234

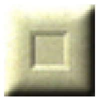
Messages: none
Action: none
Variants:


st_plaster:


st_plaster_hollow: hollow=`true`


st_plaster_movable: movable=`"true"`


st_plaster_breakable: breakable=`"true"`


st_plaster_movebreakable: movable=`"true"`, breakable=`"true"`

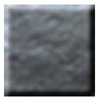
9.5.48 st_plop

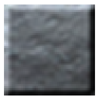
A movable stone that ceases to exist with a plop.

This stone behaves like any other standard movable stone. But unlike other stones it can cease under some conditions. And if it ceases it does it with a plop and some sparkles.

Currently there is just one flavor called `"slate"` according to its dark blue grey color. It falls and ceases to exist if pushed on Section 7.4.13 [fl_water], page 178, Section 7.4.1 [fl_abyss], page 166, or Section 7.4.11 [fl_swamp], page 177. Unlike Section 9.5.7 [st_box], page 248, it does not build a floor.

Variants:

 **st_plop**

 **st_plop_slate**

9.5.49 st_polarswitch

A special on/off switch that toggles its state on actors hitting the stone. Of course other objects can send messages on actions to make this switch turning.

The main purpose of this switch is its ability to switch crossing laser beams. While the switch is not transparent in its default off state, it switches to a transparent on state.

The switch looks like an Section 9.5.15 [st_darkglass], page 254, in its opaque off state and like an Section 9.5.37 [st_lightglass], page 275, in its transparent on state. Like other Section 9.6.1 [Transparent Stones], page 317, it is passable for invisible actors.

Attributes:

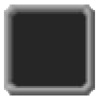
state, *values*: `ON`, `OFF`; *default*: `OFF` See Section 6.1.2 [state], page 125
: An '`OFF`' state is not transparent, an '`ON`' state is transparent.

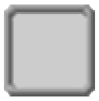
Messages:

signal See Section 6.2.3 [signal], page 130
: Switches on at value '`1`', and off at values '`0`'.

on See Section 6.2.4 [on], page 130
off See Section 6.2.5 [off], page 130

Action: See Section 6.1.3 [target], page 126, See Section 6.1.4 [action], page 126
Variants:

 **st_polarswitch**: state = `OFF`

 **st_polarswitch**: state = `ON`

9.5.50 st_portal

A gate that is just passable for some special kind of actors. Like Section 9.5.27 [st_grate], page 266, it uses metallic frames but it does not let pass actors of all kinds.

The portal stone lets just pass actors of the kind given by its attribute '`flavor`'.

The flavor `"horse"` lets just pass an Section 10.2.2 [ac_horse], page 322.

The flavor `"pearl"` lets just pass an Section 10.2.5 [ac_pearl], page 326.

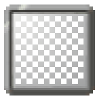
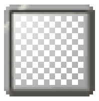
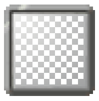
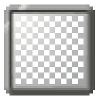
The flavor `"glass"` lets just pass the glass flavor of Section 10.2.4 [ac_marble], page 325.

As of Enigma 1.30, all of these flavors share a common image. Please note however, that future versions of Enigma might introduce different images for different flavors of '`st_portal`'.

Attributes:

flavor *values*: `"horse"`, `"pearl"`, `"glass"`; *default*: `"horse"`; *access*: read only

Messages: none
Action: none
Variants:


st_portal: flavor=`"horse"`

st_portal_horse: flavor=`"horse"`

st_portal_pearl: flavor=`"pearl"`

st_portal_glass: flavor=`"glass"`

9.5.51 st_pull

A pull stone changes its position on an initiating impulse into the reverse direction of the impulse. Thus it can not be pushed like other movable stones. But when an actor hits a pull stone it acts like being pulled. If another stone is located on the destination grid, both stones will exchange their positions. The exchange will also be performed when the pull stone receives a stone impulse via an Section 11.1.3 [ot_wire], page 331, or a neighboring Section 9.5.61 [st_stoneimpulse], page 304. A similar stone is the Section 9.5.63 [st_swap], page 306, that exchanges with stones in the forward direction of the initiating impulse.

Actors on the destination grid, including an initiating hitting actor, are pulled through it, not caged under them. The actors reappear on the old grid position of the pull stone with their old velocities.

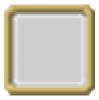
The pull stone is laser light transparent like other glass like stones.

An existing stone exchange partner is not mandatory. But if a stone is located on the destination position of a pull stone some conditions must be met for a stone exchange. Connected Section 9.4 [Cluster Stones], page 239, building a block, Section 9.5.44 [st_oxyd], page 284, configured as being '`static`', and another Section 9.5.63 [st_swap], page 306, or pull stone that is currently engaged in an own stone exchange operation will refuse swapping.

Stone exchanges will not cause item hit transformations as caused by push moved stones. But the exchanged stones will react on the new floor, e.g. causing Section 9.5.7 [st_box], page 248, to sink into water.

Further on the exchange is atomic concerning Section 8.4.18 [it_trigger], page 226, detection and laser light transparency. If the exchanged stone is not transparent, the light will pass on every time slice just on one of the two grids. If the exchanged stone is floating and does not press Section 8.4.18 [it_trigger], page 226s, the pull stone will press just one trigger, releasing the trigger of the old position before pressing the new position's trigger like any other stone being pushed from one grid to the next.

Attributes: none
Messages: none
Action: none
Variants:


st_pull

9.5.52 st_puzzle

Puzzle stones can construct large clusters of stones, that move together and can be destroyed together. There are two colors, blue and yellow puzzle stones, which behave different. Each of these color families again consists of 16 variants that differ in the location of sockets to which neighboring puzzle stones can be attached. Further on there are hollow variants of all colors and connections.

A cluster is complete as soon as all sockets of all stones are connected to matching sockets of adjacent puzzle stones of the same color, but independent of being hollow or solid. A cluster fragment still has at least one stone with an open stub. A single puzzle stone with no open sockets counts as a complete cluster.

Puzzle stone offer manifold features. A complete cluster can explode and dissolve. Cluster fragments and complete clusters can move and will sink on some floors building bridges. Rows and columns of adjacent, identical colored puzzle stones, connected and unconnected ones, can shift rotate thus allowing the player to rearrange and sort the puzzle.

Blue puzzle stones can be moved as single stones, cluster fragments and complete clusters by an actor pushing or a stone impulse by Section 11.1.3 [ot_wire], page 331, or Section 9.5.61 [st_stoneimpulse], page 304. Of course all new positions of the moving puzzle must be free of other stones. If all new positions are Section 7.4.13 [fl_water], page 178, the blue puzzle will sink and leave an object of the kind given by the global attribute Section 6.4.10 [FallenPuzzle], page 140. The replacement defaults to Section 7.3.14 [fl_gray], page 158, building a bridge over the water. The user can prohibit the sinking of the puzzle into water by pushing with a revealed Section 8.3.19 [it_magicwand], page 197. If all new positions are Section 7.4.1 [fl_abyss], page 166, just complete blue clusters will sink and build a bridge. If all new positions are either abyss or water with at least one abyss floor just complete blue clusters will sink. Note that puzzles just sink on moves. Moving a blue fragment besides another fragment on abyss so that both fragments build a complete cluster will not sink the new cluster. It will sink as a whole on the next move. If two or more stones of a cluster receive wire impulses originating from a single event, the whole cluster will move multiple times. But it will sink on the first opportunity.

Just single unconnected yellow puzzle stones can be moved by actors. They will neither sink in Section 7.4.13 [fl_water], page 178, nor fall in Section 7.4.1 [fl_abyss], page 166. Any yellow cluster of two or more stones can not be moved by actor hits. But on receiving stone impulses they move like blue puzzles.

All puzzle stone moves do not cause standard item transformations, like Section 8.3.8 [it_coin], page 190, value changes, Section 8.4.2 [it_bomb], page 211, explosions, etc. But they all are not floating and thus do press Section 8.4.18 [it_trigger], page 226s and close Section 7.4.2 [fl_bridge], page 167s.

Hollow puzzle stones let pass actors, either moving on the floor or jumping, and laser light without any interaction, too.

Complete clusters can explode and dissolve. A precondition is that the cluster is isolated from any adjacent, same colored further puzzle stone. Such clusters explode on an additional new laser beam hitting one of its solid stones. Yellow ones explode on any actor hit. Blue ones only on actor hits with a revealed Section 8.3.19 [it_magicwand], page 197. Additionally complete clusters will explode when an Section 11.1.1 [ot_cannonball], page 330, emitted by an Section 9.5.60 [st_spitter], page 302, happens to fall on top of one of the puzzle stones of the cluster.

Exploding puzzles will stay in place and do not interact any more. The exploding stones are lethal for actors hitting them, but an actor can start an explosion beneath a hollow puzzle stone and stay beneath this hollow exploding stone without harm until the puzzle dissolved.

Puzzles can be rearranged by column and row rotations. Blue puzzles react just on actor hits with a revealed wand, yellow ones on any actor hit. All colors do rotate on laser light hits. All rotations can originate only on a solid puzzle stone. All subsequent puzzle stones of the same color will shift away with the last puzzle of the line returning to the origin. This operation is called `"push_rotate"` and can be initiated by a message, too.

In case of actor hits possible explosions precede moves, which precede rotation operations. Thus you need to touch a blue puzzle row carefully with a revealed wand if the row is part of a movable cluster fragment. If the speed is sufficient for a hit operation, the cluster will move instead of an expected row rotation. An actor hit on a blue puzzle that did neither cause an explosion or a rotation will be propagated by an Section 11.1.3 [ot_wire], page 331, connected to this puzzle stone. Hits on yellow puzzle stones will never propagate to Section 11.1.3 [ot_wire], page 331, connected other stones.

Like Section 9.4 [Cluster Stones], page 239, puzzles accept a '`cluster`' attribute. A new set puzzle stone autoconnects to adjacent, same colored puzzle stones belonging to the same cluster. But once set the puzzle stone will of course not change its connections on subsequent moves or rotations. But as a level author you need to think of possible puzzle stones pushed to positions neighboring an area on which a puzzle might be set during the running game. The new set stones may autoconnect to such unexpected stones if the color and cluster number fits.

The resolver Section 13.1.6 [res.puzzle], page 382, provides easy methods to set and shuffle puzzles. The attributes '`algorithm`' and '`intensity`' are used by the resolver only.

If you need to shuffle a puzzle of your own, you can make use of the messages '`get_adjacents`' which returns the group of color matching, adjacent puzzle stones, and '`pull_rotate`' which is the exact inversion of a push rotation.

Attributes:

color *values*: `BLUE`, `YELLOW`; *default*: `BLUE`

The color of the puzzle stubs. Adjacent puzzle stones of matching colors and connections cluster to fragments.

connections, *values*: string; *default*: `nil`

Describes the connection stubs of the puzzle stone. The string is a substring of `"nesw"` listing the stubs. The sequence of the sides, north, east, south, west, is guaranteed on read access but arbitrary on write access.

cluster *values*: number; *default*: `nil`
: If set to a number all adjacent puzzle stones of the same color with the identical cluster number will build a cluster. This attribute supersedes any explicitly given connection description.

hollow *values*: `true`, `false`; *default*: `false`
: A hollow puzzle stone has a hole in its middle and allows actors to pass beneath.

algorithm, *values*: string; *default*: `nil`
intensity *values*: number; *default*: `3`
Messages:

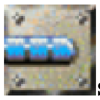
get_adjacents
: Returns the huddle of all adjacent puzzle stones of same color independent of being connected or not. The huddle is returned as a group.

pull_rotate, *value type*: orientation
: Perform a reverse '`push_rotate`' from this puzzle stone with the line of puzzle stones into the given direction.

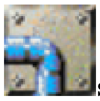
push_rotate, *value type*: orientation
: Perform a line rotation as described above from this puzzle stone with the line of puzzle stones into the given direction.

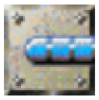
Action: none
Variants:

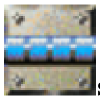
st_puzzle_blue: color = `BLUE`, connections = `""`, hollow = `false`

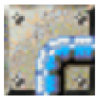

st_puzzle_blue: color = `BLUE`, connections = `"w"`, hollow = `false`

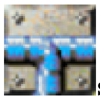
st_puzzle_blue: color = `BLUE`, connections = `"s"`, hollow = `false`


st_puzzle_blue: color = `BLUE`, connections = `"sw"`, hollow = `false`

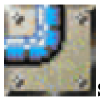

st_puzzle_blue: color = `BLUE`, connections = `"e"`, hollow = `false`

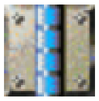

st_puzzle_blue: color = `BLUE`, connections = `"ew"`, hollow = `false`

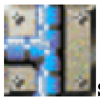

st_puzzle_blue: color = `BLUE`, connections = `"es"`, hollow = `false`

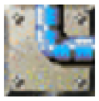

st_puzzle_blue: color = `BLUE`, connections = `"esw"`, hollow = `false`

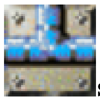
st_puzzle_blue: color = `BLUE`, connections = `"n"`, hollow = `false`

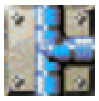

st_puzzle_blue: color = `BLUE`, connections = `"nw"`, hollow = `false`

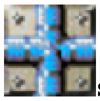

st_puzzle_blue: color = `BLUE`, connections = `"ns"`, hollow = `false`

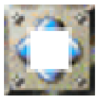

st_puzzle_blue: color = `BLUE`, connections = `"nsw"`, hollow = `false`

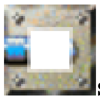

st_puzzle_blue: color = BLUE, connections = "ne", hollow = false

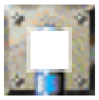

st_puzzle_blue: color = BLUE, connections = "new", hollow = false

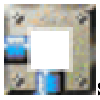

st_puzzle_blue: color = BLUE, connections = "nes", hollow = false

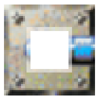

st_puzzle_blue: color = BLUE, connections = "nesw", hollow = false

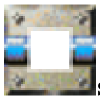

st_puzzle_blue: color = BLUE, connections = "", hollow = true

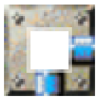

st_puzzle_blue: color = BLUE, connections = "w", hollow = true

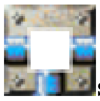

st_puzzle_blue: color = BLUE, connections = "s", hollow = true

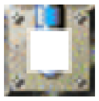

st_puzzle_blue: color = BLUE, connections = "sw", hollow = true

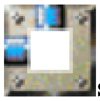

st_puzzle_blue: color = BLUE, connections = "e", hollow = true

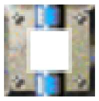

st_puzzle_blue: color = BLUE, connections = "ew", hollow = true

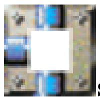

st_puzzle_blue: color = BLUE, connections = "es", hollow = true

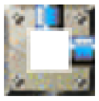

st_puzzle_blue: color = BLUE, connections = "esw", hollow = true

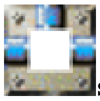

st_puzzle_blue: color = BLUE, connections = "n", hollow = true

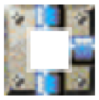

st_puzzle_blue: color = BLUE, connections = "nw", hollow = true

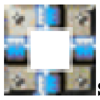

st_puzzle_blue: color = BLUE, connections = "ns", hollow = true

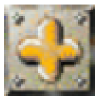

st_puzzle_blue: color = BLUE, connections = "nsw", hollow = true

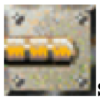

st_puzzle_blue: color = BLUE, connections = "ne", hollow = true

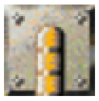

st_puzzle_blue: color = BLUE, connections = "new", hollow = true

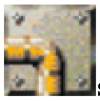

st_puzzle_blue: color = BLUE, connections = "nes", hollow = true

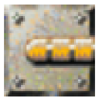

st_puzzle_blue: color = BLUE, connections = "nesw", hollow = true

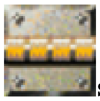

st_puzzle_yellow: color = YELLOW, connections = "", hollow = false


st_puzzle_yellow: color = YELLOW, connections = "w", hollow = false

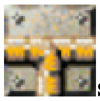

st_puzzle_yellow: color = YELLOW, connections = "s", hollow = false

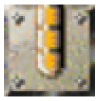

st_puzzle_yellow: color = YELLOW, connections = "sw", hollow = false

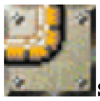

st_puzzle_yellow: color = YELLOW, connections = "e", hollow = false

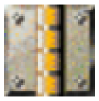

st_puzzle_yellow: color = YELLOW, connections = "ew", hollow = false

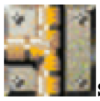
st_puzzle_yellow: color = YELLOW, connections = "es", hollow = false

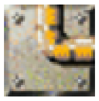

st_puzzle_yellow: color = YELLOW, connections = "esw", hollow = false

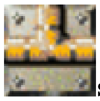

st_puzzle_yellow: color = YELLOW, connections = "n", hollow = false

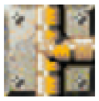

st_puzzle_yellow: color = YELLOW, connections = "nw", hollow = false

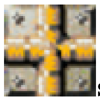

st_puzzle_yellow: color = YELLOW, connections = "ns", hollow = false

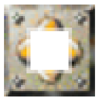

st_puzzle_yellow: color = YELLOW, connections = "nsw", hollow = false

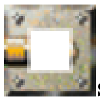

st_puzzle_yellow: color = YELLOW, connections = "ne", hollow = false

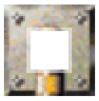

st_puzzle_yellow: color = YELLOW, connections = "new", hollow = false

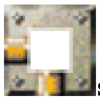

st_puzzle_yellow: color = YELLOW, connections = "nes", hollow = false

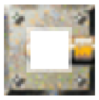

st_puzzle_yellow: color = YELLOW, connections = "nesw", hollow = false

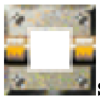

st_puzzle_yellow: color = YELLOW, connections = "", hollow = true

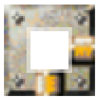

st_puzzle_yellow: color = YELLOW, connections = "w", hollow = true

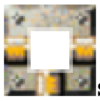

st_puzzle_yellow: color = YELLOW, connections = "s", hollow = true

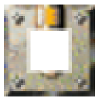

st_puzzle_yellow: color = YELLOW, connections = "sw", hollow = true

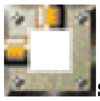

st_puzzle_yellow: color = YELLOW, connections = "e", hollow = true

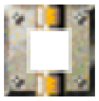

st_puzzle_yellow: color = YELLOW, connections = "ew", hollow = true

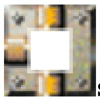

st_puzzle_yellow: color = YELLOW, connections = "es", hollow = true

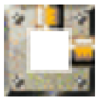

st_puzzle_yellow: color = YELLOW, connections = "esw", hollow = true

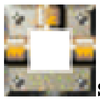

st_puzzle_yellow: color = YELLOW, connections = "n", hollow = true

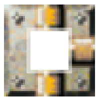

st_puzzle_yellow: color = YELLOW, connections = "nw", hollow = true

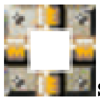

st_puzzle_yellow: color = YELLOW, connections = "ns", hollow = true


st_puzzle_yellow: color = YELLOW, connections = "nsw", hollow = true


st_puzzle_yellow: color = YELLOW, connections = "ne", hollow = true


st_puzzle_yellow: color = YELLOW, connections = "new", hollow = true


st_puzzle_yellow: color = YELLOW, connections = "nes", hollow = true


st_puzzle_yellow: color = YELLOW, connections = "nesw", hollow = true

9.5.53 st_quake

This stone looks like an Section 9.5.44 [st_oxyd], page 284, of flavor "b", but it has the unpleasant habit of quaking when being activated. Unfortunately this closes all open Section 9.5.44 [st_oxyd], page 284s.

The stone gets activated on an actor hit, on Section 9.5.6 [st_boulder], page 246s hit and on its destruction.

The player can destroy this troublemaker with an actor that reveals an Section 8.3.17 [it_hammer], page 196, by directing a laser light onto the quake stone or by a nearby explosion or ignition.

Of course you can activate and destroy it by messages and state set operations, too.

Attributes:

state, *values*: `IDLE`, `ACTIVE`, `BREAKING`; *default*: `IDLE`: See Section 6.1.2 [state], page 125
: Current state of the quake stone. You can just change the state into legal follow up states. A breaking state is final.

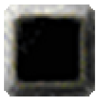
Messages:

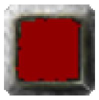
toggle See Section 6.2.1 [toggle], page 129
: Toggles stone from '`IDLE`' to '`ACTIVE`'

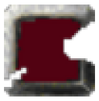
signal See Section 6.2.3 [signal], page 130
: Toggles stone from '`IDLE`' to '`ACTIVE`'

ignite
: Toggles stone to '`BREAKING`'

Action: none


st_quake: state = `IDLE`


st_quake: state = `ACTIVE`


st_quake: state = `BREAKING`

9.5.54 st_rawglass

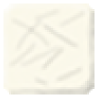
A block of raw glass. It exists in static and movable variants and is by its very nature transparent to laser light. Like other Section 9.6.1 [Transparent Stones], page 317, it is passable for invisible actors.

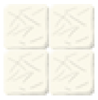
This stone comes in a second texture variant that looks like being composed of 4 small rawglasses. This '`quad`' variant is not movable.

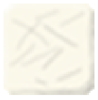
Attributes:

movable *values*: `true`, `false`; *default*: `false`; *access*: read only See Section 9.2.6 [movable], page 235

Messages: none
Variants:


st_rawglass: movable = `false`

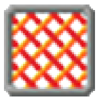

st_rawglass_quad: movable = `false`


st_rawglass_movable: movable = `true`

9.5.55 st_redfiber

A metal frame with woven red fiber. Like other Section 9.6.1 [Transparent Stones], page 317, it is passable transparent to laser light. But the redfiber is not passable to any actors.

Attributes: none
Messages: none
Variants:


st_redfiber

9.5.56 st_rotator

Rotators send impulses to neighboring stones, thus pushing them in the direction given by the rotation. Section 9.5.6 [st_boulder], page 246, additionally change their orientation to the one they are pushed to.

Rotators can either rotate in clockwise or counterclockwise direction. They can be movable or unmovable.

The rotator changes its rotation direction when hit by an actor with a revealed Section 8.3.34 [it_wrench], page 208, and by laser beams. Every additional laser beam causes a change in the rotation direction.

Attributes:

state, *values*: `CW`, `CCW`; *default*: `CW` See Section 6.1.2 [state], page 125
The rotation direction - '`CW`' for clockwise as default, or '`CCW`' for counter clockwise.

counterclock *values*: `true`, `false`; *default*: `false`
The standard rotation direction is clockwise. Use this attribute to revert the direction.

movable *values*: `true`, `false`; *default*: `false` See Section 9.2.6 [movable], page 235

Messages:

toggle See Section 6.2.1 [toggle], page 129
Switches the rotation direction.

Variants:

st_rotator: state = `CW`

st_rotator_cw: state = `CW`

st_rotator_ccw: state = `CCW`

9.5.57 st_rubberband

A rubberband stone attaches a new Section 11.1.2 [ot_rubberband], page 330, between actors hitting it and itself.

No rubberband is attached if the hitting actor is already connected to this particular stone.

If the attribute '`scissor`' is '`true`', all rubberbands connected to the hitting actor are removed prior to attaching the direct new connection.

The rubberband stone is static by default. But an actor with a revealed Section 8.3.19 [it_magicwand], page 197, can move it by hitting it. As the actor will get connected by an Section 11.1.2 [ot_rubberband], page 330, at the same time you will usually place an Section 9.5.58 [st_scissors], page 300, near the target place as an opportunity for the marble to free itself again from the rubberband stone.

Attributes:

strength *values*: number; *default*: `10.0`
The force strength.

length *values*: positive number or `AUTOLENGTH`; *default*: `1.0`
The natural length above which forces are applied.

threshold *values*: positive number or zero; *default*: `0.0`
The length smaller than the natural length below which inverted forces are applied.

min *values*: positive number or zero; *default*: `0.0`
The minimum length at which actors bounce.

max *values*: positive number or zero; *default*: `0.0`
The maximum length at which actors bounce.

scissor, *values*: `true`, `false`; *default*: `true`
Rubberband cutting behaviour on connection.

Messages: none
Variants:

st_rubberband

9.5.58 st_scissors

This stone cuts all Section 11.1.2 [ot_rubberband], page 330s attached to an actor that touches it. When at least one rubber band is cut, it performs the action given in the action/target-pair.

In addition, this is the scissors member of the rock-paper-scissors trio, the other two stones being Section 9.5.46 [st_pebble], page 288, and Section 9.5.19 [st_document], page 258. When `st_scissors` is touched, each `st_document` bordering it or being connected to it by a wire is destroyed. Similarly, when an `st_pebble` is touched, that borders or is connected to an `st_scissors`, the `st_scissors` will break.

Attributes: none
Messages: none
Action: See Section 6.1.3 [target], page 126, See Section 6.1.4 [action], page 126
Sends an action message with value '`true`' on freeing an actor from its rubberbands.

Variants:

st_scissors

9.5.59 st_shogun

Shogun stones are nestable stones like Fukuroma or Matryoshka dolls. The different basic variations are distinguishable by their central hole. Small, medium and large ones do exist. In contrast to the Fukuroma dolls you can push smaller variations beneath the larger ones but not vice versa. You can see smaller shoguns pushed beneath larger ones through the upper, larger hole. Thus the player is always aware of the stack of shogun stones positioned on a single grid.

An actor or a stone impulse hitting a shogun stack will push the smallest shogun out of the stack. The upper and larger shogun stones can never be moved out of a stack and larger shogun stones can never be pushed over smaller ones.

Section 8.4.13 [it_shogun], page 222, are a special trigger type for shogun stones represented by animated blue dots. They just react on shogun stacks positioned on top of the dot items. All shogun sizes must be present from the smallest up to the size of the dot itself.

Shogun stones press Section 8.4.18 [it_trigger], page 226, too. But all other items that react on other stones being pushed over them will not react on shogun stones. E.g. Section 8.3.26 [it_seed], page 203, will not grow, Section 8.4.2 [it_bomb], page 211, will not explode, Section 8.3.8 [it_coin], page 190, will not transform and Section 8.3.6 [it_cherry], page 188, will not smash.

All shogun stones keep their identity even if they are pushed together onto a single grid. Thus each shogun can be connected independently to Section 11.1.3 [ot_wire], page 331s or Section 11.1.2 [ot_rubberband], page 330s. On initialization you can set a stack of shogun onto a grid by setting a single shogun stone with a combined flavor string. The largest shogun stone of a stack will be positioned onto the grid and all smaller ones being part of the stack will be contained by the largest one. You can name the smaller shoguns of a stack by the additional attributes '`name_m`' and '`name_s`'. Every shogun, even those being part of a stack can individually be killed by sending a Section 6.2.11 [kill], page 131, message to it. By setting another stone or '`st_nil`' onto the grid currently being occupied by a shogun grid all shogun stones being part of the stack will be killed.

Attributes:

flavor, *values*: `"s"`, `"m"`, `"l"`, `"sm"`, `"sl"`, `"ml"`, `"sml"`; *default*: `"s"`; *access*: after initialization read only

A string describing the hole sizes of this shogun stone and all smaller shogun stones that are positioned beneath this stone. `"s"` for a small hole, `"m"` for a medium hole, `"l"` for a large hole, plus combinations of these characters for stacks. On initialization all shoguns of this grid's stack will be set according to this attribute, which can be prior set. After initialization this attribute is read only and reports the current stack configuration. The character sequence is guaranteed to be sorted from small to large on read access but is arbitrary on initial write access.

name_m *values*: string; *default*: `nil`

Name of the middle sized shogun as subpart of a stack of a large shogun.

name_s *values*: string; *default*: `nil`

Name of the small sized shogun as subpart of a stack of a large or middle sized shogun.

Messages: none
Action: none
Variants:

st_shogun: flavor = "s"

st_shogun_s: flavor = "s"

st_shogun_m: flavor = "m"

st_shogun_sm: flavor = "sm"

st_shogun_l: flavor = "l"

st_shogun_sl: flavor = "sl"

st_shogun_ml: flavor = "ml"

st_shogun_sml: flavor = "sml"

9.5.60 st_spitter

A stone that spits Section 11.1.1 [ot_cannonball], page 330s on actor hits and on proper messages. The standard spitter is '`ACTIVE`' showing a slow rotating animation. In this '`state`' the spitter reacts on actor hits, while being '`IDLE`' it is steady and will spit just on messages.

On an actor hit the spitter checks the owner's inventory for an existing Section 8.3.13 [it_extralife], page 193. If one exists that is not stuffed in an Section 8.3.1 [it_bag], page 184, it takes it and spits an Section 11.1.1 [ot_cannonball], page 330, according to the actors velocity and its own hit attributes. The cannonball flies into the resulting direction with a speed that is proportional to the actor's hit speed.

All cannonballs fly the same period of time. They fly above all other objects and cross all stone walls. The flight distance is proportional to their initial speed. On landing they cause actions on some objects and destroy others:

- Section 9.5.44 [st_oxyd], page 284, do open,
- Section 9.5.61 [st_stoneimpulse], page 304, do pulse,
- Section 9.5.71 [st_yinyang], page 316, do toggle,
- Section 9.5.52 [st_puzzle], page 292, do explode completely connected clusters,
- Section 9.5.10 [st_brownpyramid], page 251, do break,
- Section 9.5.60 [st_spitter], page 302, do break, if not being '`secure`'
- other stones do remain unmodified and protect items and floors,
- Section 8.3.11 [it_dynamite], page 192, do ignite,
- Section 8.4.4 [it_crack], page 213, do crack,
- other indestructible items do remain and protect floors,

- other items are blown away by an Section 8.4.7 [it_explosion], page 217_debris that may destruct the floor,too,
- floors dissolve via an Section 8.4.7 [it_explosion], page 217_debris if not being indestructible as Section 7.4.13 [fl_water], page 178, Section 7.4.11 [fl_swamp], page 177, Section 7.4.1 [fl_abyss], page 166.

Actors will not be harmed by falling cannonballs.

The spitting can be initiated by the message `"hit"`, too. No Section 8.3.13 [it_extralife], page 193, is needed in this case. The hit message takes either a destination as message value or in case no value is given it evaluates the '`destination`' attribute. The second case is suitable for usage of '`hit`' as an action message.

The destination can be any value that evaluates to a valid position, object references and object names included. In case of a '`destination`' attribute you can even supply tokens describing a series of destination positions. The destinations will be targeted by the cannonballs in turn on a sequence of '`hit`' actions.

Note that the destruction of target objects can have unexpected side effects on the destination sequence. If you list three Section 9.5.61 [st_stoneimpulse], page 304, as destinations they will be targeted in the given sequence as none of them gets destroyed. But if you list three Section 9.5.10 [st_brownpyramid], page 251, the first cannonball destroys the first target, leaving two valid destinations. The spitter now targets the second target of its list, which happens to evaluate to the third brown pyramid stone. Finally the destination list has just one still existing brown pyramid, the second one, as target. This one will be destroyed on the next spit as the spitter starts again on the first (remaining) destination when the end of list is reached. This may be no problem if you want to destroy objects randomly or if you use named destinations with wildcards. But if you need control about the sequence you need either destinations targets that get not destroyed or floor object references, as they represent Section 4.4.5 [Named Positions], page 60, that are persistent to object destruction.

Attributes:

state, *values*: `IDLE`, `ACTIVE`; *default*: `ACTIVE` See Section 6.1.2 [state], page 125

An '`ACTIVE`' spitter is animated and reacts on actor hits while an '`IDLE`' looks steady and does not spit on actor hits.

hit_strength *values*: floating point numbers; *default*: `1.0`; See Section 9.2.3 [hit_*], page 234
hit_distortion_xx *values*: floating point numbers; *default*: `1.0`; See Section 9.2.3 [hit_*], page 234
hit_distortion_xy *values*: floating point numbers; *default*: `0.0`; See Section 9.2.3 [hit_*], page 234
hit_distortion_yx *values*: floating point numbers; *default*: `0.0`; See Section 9.2.3 [hit_*], page 234
hit_distortion_yy *values*: floating point numbers; *default*: `1.0`; See Section 9.2.3 [hit_*], page 234
destination, *values*: tokens or position; *default*: `nil` See Section 6.1.8 [destination], page 127

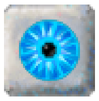
The destination of the cannonball given by an object or a position.

secure *values*: `true`, `false`; *default*: `false`
Unsecure spitters do break on a Section 11.1.1 [ot_cannonball], page 330, hit.

Messages:

hit Spit a cannonball. Takes either a destination as message value or '`nil`'.

Variants:

**st_spitter**: secure = `false`, state = `ACTIVE`

9.5.61 st_stoneimpulse

When being triggered these stones do pulse and send stone pushing impulses to their direct neighbors. There exist solid, hollow and movable variants of this stone.

The pulsing can either be triggered by an actor touching or hitting the stone, by receiving a stone impulse from a neighboring Section 9.5.61 [st_stoneimpulse], page 304, via Section 11.1.3 [ot_wire], page 331, or a dropped Section 8.3.23 [it_puller], page 200. Further on laser light, an Section 9.5.6 [st_boulder], page 246, hitting and of course messages will cause the pulsing, too.

Even though the three major variants can be set by attributes, they are mutual exclusive. A '`hollow`' stone is never movable or solid and vice versa. That means setting one of these basic attributes will reset the others to their defaults.

A movable stoneimpulse being pushed will pulse due to the actor hit at the new grid position. Even when it is pushed while pulsing it will continue the running pulse animation on the new grid and if necessary it will repulse to guarantee that impulses are sent to the neighboring stones at the new position.

But if an actor with a revealed Section 8.3.19 [it_magicwand], page 197, pushes a movable stoneimpulse it will move without any additional pulse.

In general stoneimpulse stones are very responsive to actor contacts. The slightest touch is sufficient to cause a pulsing. Hollow stones will shatter actors beneath it while pulsing.

Hollow stoneimpulse stones are transparent to laserlight and thus do not react. But all other stones do pulse. A standard not '`steady`' stoneimpulse will pulse just one time on each new added light beam. But if you set '`steady`' to `true` the stone will continue pulsing as long as a single beam hits one of its sides.

An Section 9.5.6 [st_boulder], page 246, that hits a stoneimpulse causes it to pulse once. The impulse will not backfire onto the Section 9.5.6 [st_boulder], page 246. It will just propagate to the other three directions. Thus the boulder remains aside the stoneimpulse. But when the stoneimpulse gets activated otherwise it will push back the boulder, which will in return hit the stoneimpulse again.

An Section 11.1.1 [ot_cannonball], page 330, emitted from an Section 9.5.60 [st_spitter], page 302, and now falling onto a stoneimpulse causes it to pulse, too.

On a chain of stoneimpulse stones the pulsing will propagate along the chain without backfiring, as the previous stone is still active when its successor impulses. This feature lets propagate a linear front of impulses through a field of stoneimpulse stones as expected.

If you want to setup a linear circle of stoneimpulse stones with an impulse wandering around the circle in one direction forever, you should insert one '`st_stoneimpulse_new`' into the chain. According to the Section 4.4.2 [Snapshot Principle], page 58, it is a stone that is just about to start pulsing. You need to set the attribute '`orientation`', which is just evaluated for new stones when set to the grid. It takes the incoming direction of the impulse when it reached the new stone. E.g. an orientation of east means that the stone received an impulse from a stone located west of it which was bound to east. Thus the stone will emit impulses to all directions but west.

Impulse stones will be destroyed by Section 8.3.11 [it_dynamite], page 192, exploding on one of the eight neighboring grid positions while the stone is enlightened by a laser. But other explosions, including Section 8.4.2 [it_bomb], page 211, will not effect stoneimpulse stones.

Attributes:

movable *values*: `true`, `false`; *default*: `false`
Movable stones are not hollow.

hollow *values*: `true`, `false`; *default*: `false`
Hollow stones are neither movable, nor steady.

steady *values*: `true`, `false`; *default*: `false`
Steady stones send continuous impulses while exposed to laser light. Steady stones are not hollow.

Messages:

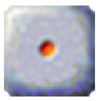
signal See Section 6.2.3 [signal], page 130
Pulse at a value of '`1`'.

Action: none
Variants:

st_stoneimpulse

st_stoneimpulse_movable: movable = `true`

st_stoneimpulse_hollow: hollow = `true`


st_stoneimpulse_steady: steady = `true`

st_stoneimpulse_new:
A stone that is about to pulse when being set.

9.5.62 st_surprise

A stone that transforms into a random stone as soon as an actor hits it.

The replacement stone is a random one out of a given selection. You can set the '`selection`' attribute with tokens of strings. Every string needs either to be an Section 4.2.1 [Object Kind], page 49, or a tile key prefixed by an equal sign '`=`'.

```
ti["b"] = {"st_brake"}
ti["d"] = {"st_death"}
ti["s"] = {"st_surprise", selection={"st_chess", "=b", "=d", "=d"}}
```

The replacement stone is randomly chosen out of the given selection. By listing a stone several times you can take influence on the likelihood.

The tile declarations referenced by a key may even contain objects besides stone. But you should make rare and proper usage of this feature.

Prior replacing the surprise stone the surprise stone will perform its action. You can use this action to modify the selection or to set objects on your own.

The surprise stone is killed by any replacement stone set to the grid position. If your selection does not resolve to a stone you may need to add `"st_nil"` to the replacement tile declaration.

Attributes:

selection, *values*: tokens of stone kinds and tile keys; *default*: `{"st_grate_cross", "st_death", "st_surprise", "st_lightglass_hollow", "st_knight", "st_thief", "st_flat_breakable", "st_flat_breaking"}`

Messages:

Action: See Section 6.1.3 [target], page 126, See Section 6.1.4 [action], page 126

Variants:

st_surprise

9.5.63 st_swap

A swap stone can exchange its position with a neighboring stone on the side in direction of the initiating impulse. It is not freely movable by pushes. But when an actor hits a swap stone and another stone is located on the opposite side of the swap stone, both stones will exchange their positions. The swap will also be performed when the swap stone receives a stone impulse via an Section 11.1.3 [ot_wire], page 331, or a neighboring Section 9.5.61 [st_stoneimpulse], page 304. A similar stone is the Section 9.5.51 [st_pull], page 291, that exchanges with stones in the reverse direction of the initiating impulse.

An existing stone exchange partner is mandatory. Nearly all stones can be swapped. Just connected Section 9.4 [Cluster Stones], page 239, building a block, Section 9.5.44 [st_oxyd], page 284, configured as being '`static`', and another swap stone or Section 9.5.51 [st_pull], page 291, that is currently engaged in an own stone exchange operation will refuse swapping.

Stone exchanges will not cause item hit transformations as caused by push moved stones. But the exchanged stones will react on the new floor, e.g. causing Section 9.5.7 [st_box], page 248, to sink into water.

Further on the exchange is atomic concerning Section 8.4.18 [it_trigger], page 226, detection and laser light transparency. If the exchanged stone is transparent, the light will pass on every time slice just on one of the two grids. If the exchanged stone is floating and does not press Section 8.4.18 [it_trigger], page 226s, the swap stone will press just one trigger, releasing the trigger of the old position before pressing the new position's trigger like any other stone being pushed from one grid to the next.

Attributes: none
Messages: none
Action: none
Variants:

st_swap

9.5.64 st_switch

A classical on/off switch that toggles its state on actors hitting the stone. Of course other objects can send messages on actions to make this switch turning.

Three variants of the switch do exist. A neutral, grey colored one that reacts on any actor hits, and a black and a white colored switch. These last two switches will react only if hit by actors of matching color.

If a switch turns on or off there will be a short delay until it reaches the new state and performs its actions. If you need a switch without delay you need to set the '`instant`' attribute.

Attributes:

state, *values*: `ON`, `OFF`; *default*: `OFF` See Section 6.1.2 [state], page 125

color *values*: `nil`, `BLACK`, `WHITE`; *default*: `nil`
The color of the switch that needs to match the hitting actor to cause a toggle. The default '`nil`' color is a grey switch that matches all actors, marbles, pearls or killers of any color as well as all other actors.

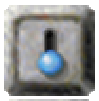
instant *values*: `true`, `false`; *default*: `false`
A default switch requires a short time equivalent to the animation until the new state is reached and the actions are performed. An instant switch jumps directly into the new state.

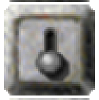
Messages:

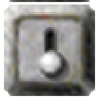
signal See Section 6.2.3 [signal], page 130
Switches on at value '`1`', and off at values '`0`'.

on See Section 6.2.4 [on], page 130
off See Section 6.2.5 [off], page 130

Action: See Section 6.1.3 [target], page 126, See Section 6.1.4 [action], page 126
Variants:

**st_switch**

**st_switch_black**: color = `BLACK`

**st_switch_white**: color = `WHITE`

9.5.65 st_thief

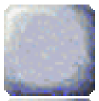
A thief steals an item from the player's inventory when it is hit by an owned actor. Unfortunately the thief is visually indistinguishable from a Section 9.3.2 [st_bluegray], page 236.

The item is not directly stolen at the moment of the hit. The hit itself just causes the thief to emerge from his hiding-place. The thief steals from the actor that did hit the stone at the moment of maximum visibility. He takes a random item from the owner's inventory. But he just will steal an item if the actor is not shielded due to an activated Section 8.3.32 [it_umbrella], page 207.

Thieves have an addiction to alcohol. Thus they get drunken and inactive if they happen to steal a bottle filled with stuff.

Thieves have an enemy - the Section 9.5.13 [st_chess], page 252. If a chess stone is pushed onto a thief it will capture the thief, sober or drunken. The thief stone vanishes and the chess stone jumps onto its position. But the thief will leave behind on the grid all stolen items in his own Section 8.3.1 [it_bag], page 184. If an item happens to be positioned beneath the captured thief stone, this item will be added to the thief's bag, too. If the thief has not stolen any items he leaves no empty bag.

Attributes: none
Messages: none
Action: none
Variants:

**st_thief**: hidden

st_thief: showing up at the moment when stealing items

st_thief: when being captured

st_thief: drunken thief

9.5.66 st_timer

This stone can be used to trigger a delayed single or periodic events. An active, switched on timer is usually visualized by an animation. An inactive, switched off timer shows a static image. An alternative to an invisible timer stone is an Section 11.2.2 [ot_timer], page 333, gadget.

Note that this is an exceptional object as its default state is '`ON`' to support the most common case of immediately running timers.

A single shot, not looping timer will send an action value of '`true`'. A looping timer will alternate the boolean action values starting with value '`true`'. You can use Section 6.1.7 [inverse], page 127, to start with a value of '`false`'.

If you stop a timer by switching it off, no further events will be performed. Restarting the timer by switching it on again will restart the timer like a new timer.

The time interval to the first event and between subsequent events can be relied on to an accuracy of 0.01 seconds. But due to performance reasons and visibility of the reactions timers should not be set to intervals below 0.1 seconds. An interval of less than 0.01 seconds is not valid for a looping timer.

Attributes:

state, *values*: `ON`, `OFF`; *default*: `ON` See Section 6.1.2 [state], page 125
An '`ON`' state timer is running. A timer in state '`OFF`' is reset and waiting for reactivation.

invisible *values*: `true`, `false`; *default*: `false`
An invisible timer is totally transparent. But the user may notice it, as actors cannot pass and other stones cannot be moved onto the same grid position.

interval *values*: positive number; *default*: `1.0`
Number of seconds until the first and between subsequent events. The interval must be larger or equal 0.01 seconds for looping timers.

loop *values*: `true`, `false`; *default*: `true`
A looping timer will send periodic events.

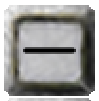
Messages:

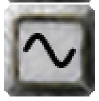
signal See Section 6.2.3 [signal], page 130
Switches on at value '`1`', and off at values '`0`'.

on See Section 6.2.4 [on], page 130
off See Section 6.2.5 [off], page 130

Action: See Section 6.1.3 [target], page 126, See Section 6.1.4 [action], page 126
The action value starts with '`true`' and alternates on every event between '`false`' and '`true`'. A timer that is reset starts again with value '`true`'

Variants:

**st_timer**: state = `OFF`

**st_timer**: state = `ON`

9.5.67 st_turnstile

A turnstile is a stone cluster that consists of a central pivot, this '`st_turnstile`', and up to four neighboring Section 9.5.68 [st_turnstilearm], page 311s of connecting orientations.

When one the arms is hit by an actor or receives a stone pushing impulse by another object (e.g. '`st_rotator`', '`ot_wire`', '`it_puller`', ...), the whole cluster turns by 90 degrees into the impulse direction. Of course the turnstile complex just turns if it is not blocked by other stones in its surrounding. Even movable stones will block turnstiles.

There are two '`flavor`'s of turnstiles. The common '`red`' version pulls only the actor, that did hit the arm. It keeps it behind the '`st_turnstilearm`' and shatters all others in its surrounding. Whereas the '`green`' version pushes all actors with its attached '`st_turnstilearm`'s and keeps them in front of the arms. Just actors being in range of the arms will be pushed. That means that they need to be in a distance of less than 1.5 grids to the center of the pivot. Thus actors located at the very edge of the diagonal grid positions will not be pushed. As actors can not be moved out of the world, a green turnstile positioned at the level border that moves an arm to the border will shatter actors instead.

Any actor moved by a turnstile is directly warped to its new position without touching any grid in between. Thus actors can pass abyss or water floors, but they will not grab any items located on the grid positions in between. The relative position of an actor within the grid is maintained during its circular move. Thus two small actors moved at the same time keep their relative positioning. It is guaranteed that any moved actors will fall even into a tiny Section 8.4.11 [it_meditation], page 219_dent that is positioned at the destination grid.

Items in the range of the rotating arms will act like a stone being pushed over them.

When green turnstiles push actors to a diagonal grid position they will push away an Section 9.5.68 [st_turnstilearm], page 311, and just this single kind of stone, if it is located on this target grid. This feature can be used to intertwine several turnstiles as it can be seen in the level '`ZigZag`'.

There are two other ways of coupling turnstiles. You can simply set another '`st_turnstile`' as the target of a first one and perform a '`signal`' action. This will turn both turnstiles in the same direction. But if one is blocked the rotations will desynchronize.

Another way is the coupling of two Section 9.5.68 [st_turnstilearm], page 311s via an Section 11.1.3 [ot_wire], page 331. A turnstile will propagate its rotation impulses via a wire that is connected at one of its arms. Two turnstiles connected by wired arms will resynchronize in their rotation even if one of them is temporarily blocked.

Turnstiles can be turned by standard messages and attributes. They do even evaluate the turns and keep the attribute '`orientation`' up to date for easy read evaluation of the current turnstile orientation.

Attributes:

flavor *values*: `"red"`, `"green"`; *default*: `"red"`
: The distinguishing color of the pivot that signals the behaviour.

counterclock *values*: `true`, `false`; *default*: `false`
: The standard turning direction is clockwise. Use this attribute to revert the direction.

orientation, *values*: `NORTH`, `EAST`, `SOUTH`, `WEST`; *default*: `NORTH`
: The orientation of the turnstile that is only visible by its arms. Setting this attribute just defines a new base, but does not turn the turnstile as the orientation would not be defined. But every rotation does update this attribute relative to its previous value.

Messages:

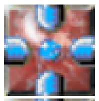
signal See Section 6.2.3 [signal], page 130
Rotates the turnstile counterclockwise on '`1`', and clockwise at values '`0`'.

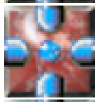
turn Turns in turning direction as defined by attribute '`counterclock`'.

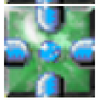
turnback Turns in opposite turning direction as defined by attribute '`counterclock`'.

Action: See Section 6.1.3 [target], page 126, See Section 6.1.4 [action], page 126
At the end of each turn the action is performed with a value of '`true`' on counterclock turns and '`false`' on clockwise turns.

Variants:


st_turnstile: flavor = `"red"`


st_turnstile_red: flavor = `"red"`


st_turnstile_green: flavor = `"green"`

9.5.68 st_turnstilearm

An arm that usually connects to an Section 9.5.67 [st_turnstile], page 309, pivot building a turnstile cluster. The arm's subkind suffix, its state and orientation are named according to the arm's position within the turnstile cluster. Thus a '`NORTH`' arm has a single standard connection of `"s"`, the reverse orientation.

As long as a turnstile arm is not connected to a pivot it is a free movable stone. Intentionally it is visually indistinguishable from a Section 9.5.52 [st_puzzle], page 292, with the same connections. But neither an arm will not connect to other Section 9.5.52 [st_puzzle], page 292, nor a puzzle to a pivot.

An arm is connected to a pivot on a neighboring grid position solely by a matching connection. It is no longer freely movable. All its impulses will turn the Section 9.5.67 [st_turnstile], page 309, cluster instead.

A special move of an arm is due to actors being moved by another green Section 9.5.67 [st_turnstile], page 309, to its position. The arm receives an impulse by the other pivot and will either move straight forward or turn its own pivot if being part of a cluster.

The orientation of an arm can be set by attribute or messages. Neither way will generate an impulse to turn a connected turnstile cluster. The arm will be reorientated alone.

Attributes:

state, *values*: `NORTH`, `EAST`, `SOUTH`, `WEST`; *default*: `NORTH` See Section 6.1.2 [state], page 125
The position of an arm in a turnstile cluster.

orientation, *values*: `NORTH`, `EAST`, `SOUTH`, `WEST`; *default*: `NORTH`
The position of an arm in a turnstile cluster.

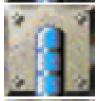
connections *values*: string; *default*: `"s"`
Describes the Section 9.5.52 [st_puzzle], page 292, like connection that is the opposite of the orientation. The string is a string of a single character describing the sole connection.

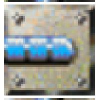
Messages:

orientate, *value type*: orientation
Change the orientation to the given orientation value. The Section 9.5.25 [st_fourswitch], page 264, provides a compatible action which allows you to set an arm as target and this message as action.

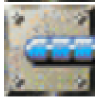
Action: none
Variants:

st_turnstilearm: orientation = `NORTH`


st_turnstilearm_n: orientation = `NORTH`


st_turnstilearm_e: orientation = `EAST`

st_turnstilearm_s: orientation = `SOUTH`


st_turnstilearm_w: orientation = `WEST`

9.5.69 st_volcano

A volcano stone spreads slowly to neighboring grid positions filling up complete areas and will just stop on boundaries set by other stones.

A volcano can either start by the setting of an '`ACTIVE`' variant, by an inactive '`IDLE`' variant being triggered by a message or a hitting Section 9.5.6 [st_boulder], page 246, or by an Section 8.3.26 [it_seed], page 203, of flavor `volcano` being dropped or triggered.

Once being activated a volcano stone spreads randomly to its direct neighbor positions. Even though the new set volcano seeds can be passed by actors without harm for a short period of time the volcano gets lethal while growing. After reaching its full size a volcano remains for a random time in an active, glowing state spreading to neighbour positions. During this phase an actor with a revealed Section 8.3.17 [it_hammer], page 196, can destroy the active volcano stone.

The spreading of the volcano can be made '`secure`' by setting this attribute to '`true`'. Per default the spreading in not secure and a volcano may stop spreading with a certain chance anywhere, but especially in narrow gateways. In contrast a secure volcano remains active until it is guaranteed that all its neighbor grid positions will be filled with volcano stones.

After its active phase a volcano reaches its final inactive state and can not be reactivated anymore.

A volcano stone will press any Section 8.4.18 [it_trigger], page 226, as soon as it starts growing.

!!Work in progress!! special behaviour on items and floors may yet be added

Attributes:

state, *values*: `IDLE`, `ACTIVE`; *default*: `IDLE` See Section 6.1.2 [state], page 125

Inactive, finished and breaking volcano will report an '`IDLE`' state, new, growing and active volcano will report an '`ACTIVE`' state. An inactive volcano can be activated by setting the state to '`ACTIVE`'. All other attempts to set the state will be silently ignored.

secure *values*: `true`, `false`; *default*: `false`

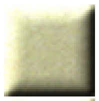
A secure volcano will spread a complete area with guarantee.

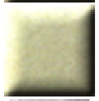
Messages:

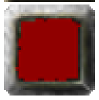
toggle See Section 6.2.1 [toggle], page 129

Activates an inactive volcano stone.

Variants:


st_volcano: state = `IDLE`


st_volcano_idle: state = `IDLE`


st_volcano_active: state = `ACTIVE`

st_volcano_new:

An active volcano starting in the seed like phase.

st_volcano_growing:

An active volcano starting in the growing phase.

9.5.70 st_window

A stone made up just of glass window faces. All combinations of window faces with at least one face are possible. There exist two versions of windows, normal blue colored glass and green colored safety glass, that is nearly indestructible. Safety glass is selected by setting the attribute '`secure`' to '`true`'. Every glass face can be weakened by '`scratches`' which are visible in the shadows.

All windows are transparent to laser light.

Slowly moving actors will bounce from window faces on any side. They can freely move within the inner part of the window stone. Invisible actors can even pass the normal blue window faces, but not the green safety glass faces.

Fast moving actors can blast normal blue window faces into smithereens. But too strong hits will cause marbles to shatter themselves. An actor can lower the required speed by adding Section 8.3.33 [it_weight], page 208, by revealing an Section 8.3.17 [it_hammer], page 196, or by weakening the window faces by prior scratching it with an Section 8.3.24 [it_ring], page 201. Green safety glass windows will never break on actor attacks and actors will not shatter on hitting safety glass.

Bomb explosions can shatter window faces, too. Normal blue window faces adjacent to a bomb explosion will break. Green safety glass faces will break only if prior weakened by an Section 8.3.24 [it_ring], page 201, scratch.

Window faces can be rearranged by actors with a revealed Section 8.3.34 [it_wrench], page 208. Pushing a face from the outside may move it to the opposite side of the window. But it will only move to the opposite side if there is not already a window face. And additionally the grid position adjacent to the opposite side must be free of a stone. Just another window stone without an adjacent window face is allowed on this position. The reason is, that the moving window face will push non static items and any actors positioned on the affected window grid to the next grid. If this grid is already occupied by an item, the window grid item will be Section 8.4.15 [it_squashed], page 224.

Window face rearrangements can also be initiated by an Section 8.3.23 [it_puller], page 200, dropped within the window and by the message '`inner_pull`'.

Windows do support Section 13.2.2 [Flood Spreading], page 390, and Section 13.2.3 [Fire Spreading], page 392, through open faces.

Attributes:

faces *values*: string; *default*: `"s"`
Describes the window faces of the stone. The string is a substring of `"nesw"` listing the faces. The sequence of the sides, north, east, south, west, is guaranteed on read access but arbitrary on write access.

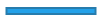
secure *values*: `true`, `false`; *default*: `false`
Green safety glass is secure, whereas normal blue is not.

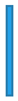
scratches *values*: string; *default*: `""`
Describes the scratched window faces of the stone. The string is a substring of `"nesw"` listing the affected faces. The sequence of the sides, north, east, south, west, is guaranteed on read access but arbitrary on write access.

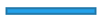
Messages:

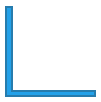
inner_pull, *value type*: orientation
Tries to tear the opposite window face into the given orientation.

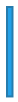
Variants:

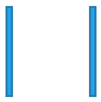

st_window: faces = `"s"`, secure = `false`

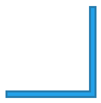

st_window_w: faces = `"w"`, secure = `false`

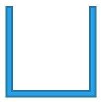

st_window_s: faces = `"s"`, secure = `false`

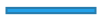

st_window_sw: faces = `"sw"`, secure = `false`

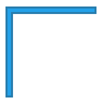

st_window_e: faces = `"e"`, secure = `false`

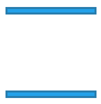

st_window_ew: faces = `"ew"`, secure = `false`

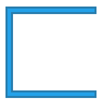

st_window_es: faces = `"es"`, secure = `false`

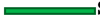

st_window_esw: faces = `"esw"`, secure = `false`

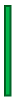

st_window_n: faces = `"n"`, secure = `false`

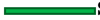

st_window_nw: faces = `"nw"`, secure = `false`

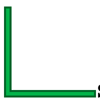

st_window_ns: faces = `"ns"`, secure = `false`

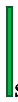

st_window_nsw: faces = `"nsw"`, secure = `false`

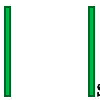

st_window: faces = `"s"`, secure = `true`

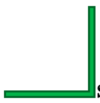

st_window_w: faces = `"w"`, secure = `true`

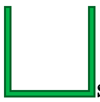

st_window_s: faces = `"s"`, secure = `true`

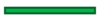

st_window_sw: faces = `"sw"`, secure = `true`

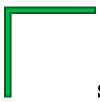

st_window_e: faces = `"e"`, secure = `true`

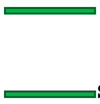

st_window_ew: faces = `"ew"`, secure = `true`

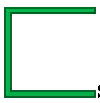

st_window_es: faces = `"es"`, secure = `true`

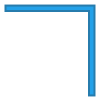

st_window_esw: faces = `"esw"`, secure = `true`

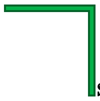

st_window_n: faces = `"n"`, secure = `true`

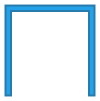

st_window_nw: faces = `"nw"`, secure = `true`

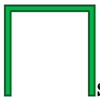

st_window_ns: faces = `"ns"`, secure = `true`

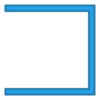

st_window_nsw: faces = `"nsw"`, secure = `true`

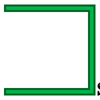

st_window_ne: faces = "ne", secure = false

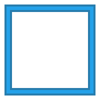

st_window_ne: faces = "ne", secure = true

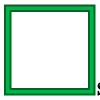

st_window_new: faces = "new", secure = false


st_window_new: faces = "new", secure = true


st_window_nes: faces = "nes", secure = false


st_window_nes: faces = "nes", secure = true


st_window_nesw: faces = "nesw", secure = false


st_window_nesw: faces = "nesw", secure = true

9.5.71 st_yinyang

A special switch that allows the user to toggle the Section 4.1.5 [Player and Inventory], page 48, between `YIN` and `YANG`.

In contrast to Section 8.3.35 [it_yinyang], page 209, the player can not switch at any point of time but is limited to situations where he can hit the stone by one of the actors he controls. Of course other objects can send `"toggle"` messages on actions to this switch, too. Additionally an Section 11.1.1 [ot_cannonball], page 330, emitted by an Section 9.5.60 [st_spitter], page 302, that now happens to fall on top of a yinyang stone activates it, too.

When being activated the yinyang stone switches from the '`IDLE`' state to the '`ACTIVE`' state which is animated by a turning yinyang symbol. By default the player switch takes place at the end of this animation with the stone returning to its '`IDLE`' state.

If you need a yinyang stone that switches without delay you need to set the '`instant`' attribute to '`true`'. The animation is executed after the switching. Note that even an instant stone variant can not be reactivated until it returns to its '`IDLE`' state after the completion of the animation.

By default the yinyang stone loops between its two states '`IDLE`' and '`ACTIVE`'. This means the user can hit the stone many times causing every time a player toggle action. But if you set '`loop`' to '`false`' the yinyang stone will forward to the state '`INACTIVE`' after the next activation. Thus the user can use this stone just once to toggle the players.

You can use an instance of this stone to toggle the player directly at the start of the level. Use an '`ACTIVE`' yinyang stone to switch after a short period of animation, or set additionally '`instant`' to '`true`' to switch the player before the user can act on `YIN`.

Attributes:

state, *values*: `IDLE`, `ACTIVE`, `INACTIVE`; *default*: `IDLE` See Section 6.1.2 [state], page 125

An '`IDLE`' yinyang is ready for activation. An '`ACTIVE`' yinyang is performing its animation and rejects any further attempts to reactivate. An '`INACTIVE`' yinyang reached its final state and can not be reactivated by actor hits or toggle messages.

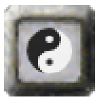
instant *values*: `true`, `false`; *default*: `false`
A default yinyang stone toggles the player after a short period of animation. An instant yinyang switches directly with start of the animation.

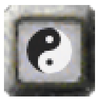
loop *values*: `true`, `false`; *default*: `true`
A looping yinyang returns to '`IDLE`' state after completion of the '`ACTIVE`' state. A yinyang with a '`loop`' value of '`false`' forwards to the final '`INACTIVE`' state

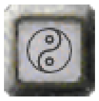
Messages:

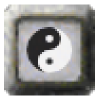
toggle See Section 6.2.1 [toggle], page 129
Activate the yinyang like an actor hitting the stone.

Action: See Section 6.1.3 [target], page 126, See Section 6.1.4 [action], page 126
Variants:


st_yinyang: state = `IDLE`


st_yinyang_active: state = `ACTIVE`


st_yinyang_inactive: state = `INACTIVE`


st_yinyang_instant: instant = `true`, state = `IDLE`

9.6 Stone Feature Summaries

9.6.1 Transparent Stones

Enigma provides a collection of transparent stones, all similar, but with different features. Some of them may be passed after the use of an Section 8.3.6 [it_cherry], page 188, others will be just pushed. Some are transparent for lasers, but not all! This table shows their exact properties.

class	**kind:**	**actor is visible:**	**actor is invisible:**	**lasertransparent:**
Section 9.5.54 [st_rawglass], page 298,	st_rawglass	rebound	pass	yes
Section 9.5.54 [st_rawglass], page 298,	st_rawglass_movable	push	pass	yes
Section 9.5.37 [st_lightglass], page 275,	st_lightglass	rebound	pass	yes

Section 9.5.37 [st_lightglass], page 275,	st_lightglass_movable	push	push	yes
Section 9.5.37 [st_lightglass], page 275,	st_lightglass_hollow	pass	pass	yes
Section 9.5.15 [st_darkglass], page 254,	st_darkglass	rebound	pass	no
Section 9.5.15 [st_darkglass], page 254,	st_darkglass_movable	push	push	no
Section 9.5.15 [st_darkglass], page 254,	st_darkglass_hollow	pass	pass	yes
Section 9.5.55 [st_redfiber], page 298,	st_redfiber	rebound	rebound	yes
Section 9.5.49 [st_polarswitch], page 290,	st_polarswitch_on	toggle	pass	yes
Section 9.5.49 [st_polarswitch], page 290,	st_polarswitch_off	toggle	pass	no
Section 9.5.3 [st_beads], page 244,	st_beads	leave	pass	no
Section 9.5.38 [st_lightpassenger], page 275,	st_lightpassenger_off	rebound	rebound	no
Section 9.5.29 [st_ice], page 267,	st_ice	push	push	yes
Section 9.3.10 [st_invisible], page 237,	st_invisible	rebound	rebound	no
Section 9.3.10 [st_invisible], page 237,	st_invisible_movable	push	push	no
Section 9.3.10 [st_invisible], page 237,	st_invisible_hollow	pass	pass	no
Section 9.5.26 [st_ghost], page 265,	st_ghost_purplemarble	rebound	rebound	no

Section 9.5.26 [st_ghost], page 265,	st_ghost_greenbrown	rebound	rebound	yes
Section 9.5.26 [st_ghost], page 265,	st_ghost_break	rebound	rebound	yes

These entries can be memorized as follows: A stone is transparent for laser light if it is hollow, but not if it is dark. Exception is '`st_beads`', whose irregular sides would scatter the beam. A stone can always be passed by invisible actors, with three exceptions: '`st_redfiber`', whose inside is filled with red stripes, and the two movables '`st_lightglass_movable`' and '`st_darkglass_movable`' which have a non-glass frame which the actor can use to move the stone. `st_rawglass_movable` does not have such a frame and can not be moved by an invisible actor.

9.6.2 Breakable Stones

10 Actor Objects

10.1 Actor Attributes

10.1.1 adhesion (actor)

The responsiveness of an actor on mouse movements. It is a scalar factor to the accelerating force applied to the actor. Note that mouse forces are only applied to an actor if the Section 10.1.3 [controllers], page 320, attribute allows forces at all. Vice versa you should exclude an actor from mouse forces by usage of the Section 10.1.3 [controllers], page 320, attribute instead of setting its adhesion to zero. The adhesion may take negative values, too. Such values correspond to inverse forces.

Type: number
Values: float number
Default: `0.0`
Access: read/write

10.1.2 charge

The initial electrical charge that a new actor starts with when being added to the world. Actors do charge and recharge by hitting Section 9.5.12 [st_charge], page 251. Hits of charged actors among themselves do not affect their charge load. Each actor keeps its charge load.

The electrical force on a charged actor is given by its own load and the load and position of all other charged actors. Note that a constant global factor Section 6.4.8 [ElectricStrength], page 139, is applied, too. If this factor is negative, equal charged actors may even attract each other.

Type: number
Values: float number
Default: `0.0`
Access: read/write

10.1.3 controllers

The players that can control the actor by their mouse movements.

Type: number
Values: `CTRL_NONE`, `CTRL_YIN`, `CTRL_YANG`, `CTRL_YINYANG`
Default: `CTRL_NONE`
Access: read/write

10.1.4 color

The logical color of the actor. All actors besides Section 10.2.4 [ac_marble], page 325s, Section 10.2.5 [ac_pearl], page 326s and Section 10.2.3 [ac_killer], page 324s will report color `nil`. The color of an actor can not be changed, it is a read only attribute.

Type: number
Values: `BLACK`, `WHITE`, `GLASS`, `nil`
Default: `nil`
Access: read only

10.1.5 essential

Describes the necessity of an actor to be alive in case of multiple actors being attached to a player. A value '`DISPENSABLE`' marks an actor as not essential. The player may well continue to play with other actors that he controls which are still alive. A value of '`INDISPENSABLE`' marks an actor as totally necessary. If such an actor cannot be resurrected after a death, the player is essentially dead. A value of '`PERKIND`' marks an actor as partially essential. Not the actor itself needs to survive but the number of actors of its kind controlled by the player need to be larger than the number of actors with value '`PERKIND`'. For example, marking 4 out of 5 Section 10.2.5 [ac_pearl], page 326, with '`PERKIND`' means that the player is dead if 2 pearls are no longer alive.

Of course shattered or sunken actors will first be resurrected if an Section 8.3.13 [it_extralife], page 193, is available and the global attribute Section 6.4.5 [ConserveLevel], page 138, allows a resurrection.

For more details about level restart see Section 4.4.7 [Level Restart], page 61.

Type: number
Values: `DISPENSABLE`, `INDISPENSABLE`, `PERKIND`
Default:
Access: read/write

10.1.6 essential_id

Since a player may control actors of different kinds at the same time, the essentialness of actors is limited to its kind via this id. It is possible to group actors of different kinds into an essential group via this id. The engine keeps this id even if actors are transformed into other kinds like on activation of an Section 8.3.10 [it_drop], page 191.

Type: string
Values: any
Default: model name of actor
Access: read/write

10.1.7 owner

The player that owns the actor. The owner gets all items picked up by an actor added to his inventory. The ownership of an actor does not influence the ability of a player to control the actors movements. Note that you need to assign the value `DEFAULT` in Lua tables to set the value `nil` due to the well known Lua table [Caveats], page 377. The other two values `YIN` and `YANG` are common Section 6.3.1 [state values], page 132.

Type: number
Values: `YIN`, `YANG`, `nil`
Default: `nil`
Access: read/write

10.1.8 velocity_x

The velocity into x direction that a new actor starts with when being added to the world. Even though this attribute is readable it does not reflect the current velocity of an actor during runtime.

Type: number
Values: float number
Default: `0.0`
Access: read/write

10.1.9 velocity_y

The velocity into y direction that a new actor starts with when being added to the world. Even though this attribute is readable it does not reflect the current velocity of an actor during runtime.

Type: number
Values: float number
Default: `0.0`
Access: read/write

10.2 Actors

10.2.1 ac_bug

An actor that looks like a small grey ball with two red dots on it. Bugs are harmless actors that do not affect other actors and they are usually passive.

In contrast to the main actors they can not jump or pass an Section 8.4.19 [it_vortex], page 227, and will not sink, fall or shatter. Bugs are immortal.

Note that you need to set '`controllers`' as well as '`adhesion`' to proper values if you want a player to control a bug directly. If a bug is owned by a player Section 7.4.12 [fl_thief], page 178, and Section 9.5.65 [st_thief], page 308, will steal items from it.

Attributes: common actor attributes

adhesion *values*: number; *default*: `0.0`; See Section 6.1.10 [adhesion], page 128
controllers *values*: `CTRL_NONE`, `CTRL_YIN`, `CTRL_YANG`, `CTRL_YINYANG`; *default*: `CTRL_NONE`; See Section 10.1.3 [controllers], page 320
owner *values*: `YIN`, `YANG`, `nil`; *default*: `nil`; See Section 10.1.7 [owner], page 321
mass *values*: positive float number; *default*: `0.7`; *access*: read only

Messages: none
Variants:

ac_bug: color = `nil`, controllers = `CTRL_NONE`, owner = `nil`

10.2.2 ac_horse

A large blue disc like actor. It is called a horse because in some future Enigma release Section 10.2.4 [ac_marble], page 325s and Section 10.2.5 [ac_pearl], page 326s should be able to ride on it.

In contrast to the main actors it can not jump or pass an Section 8.4.19 [it_vortex], page 227, and will not sink, fall or shatter. A horse is immortal.

By default a horse is a passive actor. But nevertheless a horse may move along its own path. A set of attributes let you control the movement in various ways.

The most simple approach just uses the attributes '`destination`' and '`strength`'. You can mark a path marked by an arbitrary number of positions given as Section 6.1.8 [destination], page 127s. The horse will try to reach the destinations one in a row with a force given by the strength attribute. As soon as one destination has been reached the horse targets for the next position and will start over again as soon as the last position has been reached. In this '`steady`' mode the horse is continously accelerated into the direction of the next destination target. If it misses the destination on the first approach it will return by a loop again until it finally passes the target position. This approach is rather crude and not well suited for a precise control needed if the horse should hit certain stones or move on a well defined trajectory.

Setting '`steady`' to the value `false` causes another accelaration algorithm that will decelerate the horse on approach to its target position. This allows a very precise control over the path taken by the horse.

Furtheron you can request anytime the index of the current destination target. You can even set '`destidx`' anytime. Note that this index counts the destination targets starting with 0 and taking every position into account, which might not be in sync with the destination token number in case a single token part addresses several positions at a time.

Furtheron you can control the behaviour of the horse when it reaches the last destination target. It either stops or restarts if the attribute '`loop`' is set to `true`.

Setting either '`destination`' to `nil`, '`destidx`' or '`strength`' to a negative value causes the horse to stop its automatic travel.

On its move a horse tries to reach the target position. But if the target position is blocked by a stone, the horse continues its travel targeting the next destination position as soon as it hits the stone. Thus you can use the horse to toggle Section 9.5.64 [st_switch], page 307, and other active stones.

Whenever the horse reaches a target position it will perform its action. You can reset the '`destination`' and other attributes within the callback to define a new destination target.

Note that you need to set '`controllers`' as well as '`adhesion`' to proper values if you want a player to control a horse directly.

Attributes:

adhesion *values*: number; *default*: `0.0`; See Section 6.1.10 [adhesion], page 128
controllers *values*: `CTRL_NONE`, `CTRL_YIN`, `CTRL_YANG`, `CTRL_YINYANG`; *default*: `CTRL_NONE`; See Section 10.1.3 [controllers], page 320
owner *values*: `YIN`, `YANG`, `nil`; *default*: `nil`; See Section 10.1.7 [owner], page 321
destination, *values*: position or tokens; *default*: `nil` See Section 6.1.8 [destination], page 127

A path given by a sequence of positions.

destidx *values*: integer number; *default*: `0`

The index of the targeted destination.

loop *values*: `true`, `false`; *default*: `true`
: Flag that determines whether '`destidx`' is reset to its default when the last destination has been reached.

strength *values*: float number; *default*: `+10.0`
: A scalar factor for the horse force that drives it to the next destination.

steady *values*: `true`, `false`; *default*: `true`
: Flag that determines the chosen acceleration algorithm. On steady force the actor is continuously accelerated in direction to the next destination. If it misses the destination it will loop. If steady is false the force will switch its sign as soon as the actor reaches a critical distance. Thus the actor will reach the destination with nearly no remaining speed.

mass *values*: positive float number; *default*: `1.2`; *access*: read only

Messages: none

Action: See Section 6.1.3 [target], page 126, See Section 6.1.4 [action], page 126
Performed on every reached destination position or on stone hits when the destination position is blocked by a stone.

Variants:

ac_horse: controllers = `CTRL_NONE`, owner = `nil`

10.2.3 ac_killer

An actor that looks like a white Section 10.2.5 [ac_pearl], page 326, but is a death bringing killer ball that shatters Section 10.2.4 [ac_marble], page 325s and Section 10.2.5 [ac_pearl], page 326s on contact.

In contrast to the main actors it can not jump or pass an Section 8.4.19 [it_vortex], page 227, and will not sink, fall or shatter. A killer ball is immortal.

A killer is preset to its standard attribute values, that let both players control the actor and do assign a higher '`adhesion`' to it than to Section 10.2.5 [ac_pearl], page 326s.

Note that even though a killer looks quite dangerous, Section 7.4.12 [fl_thief], page 178, and Section 9.5.65 [st_thief], page 308, do steal items from them, if the killer is owned by a player.

Attributes:

color *values*: `BLACK`, `WHITE`; *default*: `WHITE`; *access*: read only
: The color of the killer.

adhesion *values*: number; *default*: `2.0`; See Section 6.1.10 [adhesion], page 128

controllers *values*: `CTRL_NONE`, `CTRL_YIN`, `CTRL_YANG`, `CTRL_YINYANG`; *default*: `CTRL_YINYANG`; See Section 10.1.3 [controllers], page 320

owner *values*: `YIN`, `YANG`, `nil`; *default*: `nil`; See Section 10.1.7 [owner], page 321

mass *values*: positive float number; *default*: `0.7`; *access*: read only

Messages: none

Variants:

ac_killer: color = `WHITE`, controllers = `CTRL_YINYANG`, owner = `nil`

ac_killer_black: color = `BLACK`, controllers = `CTRL_YINYANG`, owner = `nil`

ac_killer_white: color = `WHITE`, controllers = `CTRL_YINYANG`, owner = `nil`

10.2.4 ac_marble

The main actor in the shape of a large ball, black, white or transparent (glass). Marbles are versatile actors that can jump, pass Section 8.4.19 [it_vortex], page 227, but on the other hand they can sink, fall and shatter, too.

As long as the '`owner`' has an Section 8.3.13 [it_extralife], page 193, in his inventory a dying marble will be resurrected. If no extra life is available a dying actor ends up in the '`state`' dead and can no longer be controlled.

The marbles are preset to their standard attribute values. Marbles can be recolored by using Section 9.5.30 [st_inkwell], page 269, but not by addressing the '`color`' attribute directly. The marble's state changes due to events and can be read only, too.

Laser beams shatter black and white marbles, unless they are protected by Section 8.3.32 [it_umbrella], page 207. Glass marbles are not harmed by laser beams, but break on harsh impacts (particularly on edges) and therefore cannot push movable stones (unless protected by Section 8.3.32 [it_umbrella], page 207). Black and white marbles drown in Section 7.4.13 [fl_water], page 178, and (though slowly) in Section 7.4.11 [fl_swamp], page 177. Glass marbles do not drown.

Attributes:

state, *values*: `ALIVE`, `DEAD`; *default*: `ALIVE`; *access*: read only
See Section 6.1.2 [state], page 125.

color *values*: `BLACK`, `WHITE`, `GLASS`; *default*: `BLACK`; *access*: read only
The color of the marble.

adhesion *values*: number; *default*: `1.0`
See Section 6.1.10 [adhesion], page 128.

controllers *values*: `CTRL_NONE`, `CTRL_YIN`, `CTRL_YANG`, `CTRL_YINYANG`; *default*: `CTRL_NONE`
See Section 10.1.3 [controllers], page 320.

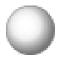
owner *values*: `YIN`, `YANG`, `nil`
default: `nil`; See Section 10.1.7 [owner], page 321.

mass *values*: positive float number
default: `1.0` for black and white marbles, `0.5` for glass marbles; *access*: read only

Messages: none
Variants:

ac_marble: color = `BLACK`, controllers = `CTRL_YIN`, owner = `YIN`

ac_marble_black: color = `BLACK`, controllers = `CTRL_YIN`, owner = `YIN`


ac_marble_white: color = `WHITE`, controllers = `CTRL_YANG`, owner = `YANG`

ac_marble_glass: color = `GLASS`, controllers = `CTRL_YIN`, owner = `YIN`

10.2.5 ac_pearl

The main actor for meditation levels in the shape of a small ball, available in black and white; glass pearls are planned for 1.30. Pearls are like marbles versatile actors that can jump, pass Section 8.4.19 [it_vortex], page 227, but on the other hand they can sink, fall and shatter, too.

As long as the '`owner`' has an Section 8.3.13 [it_extralife], page 193, in his inventory a dying marble will be resurrected. If no extra life is available a dying actor ends up in the '`state`' dead and can no longer be controlled.

The pearls are preset to their standard attribute values. The pearls state changes due to events and can be read only.

Attributes:

state, *values*: `ALIVE`, `DEAD`; *default*: `ALIVE`; See Section 6.1.2 [state], page 125; *access*: read only
color *values*: `BLACK`, `WHITE`; *default*: `WHITE`; *access*: read only
The color of the pearl.

adhesion *values*: number; *default*: `1.0`; See Section 6.1.10 [adhesion], page 128
controllers *values*: `CTRL_NONE`, `CTRL_YIN`, `CTRL_YANG`, `CTRL_YINYANG`; *default*: `CTRL_NONE`; See Section 10.1.3 [controllers], page 320
owner *values*: `YIN`, `YANG`, `nil`; *default*: `nil`; See Section 10.1.7 [owner], page 321
mass *values*: positive float number; *default*: `0.7`; *access*: read only

Messages: none
Variants:

ac_pearl: color = `WHITE`, controllers = `CTRL_YINYANG`, owner = `YIN`

ac_pearl_black: color = `BLACK`, controllers = `CTRL_YINYANG`, owner = `YIN`

ac_pearl_white: color = `WHITE`, controllers = `CTRL_YINYANG`, owner = `YIN`

10.2.6 ac_rotor

A rotating actor build up of 4 greenish cudgels. It is a death bringing actor that shatters Section 10.2.4 [ac_marble], page 325s and Section 10.2.5 [ac_pearl], page 326s on contact. Its behaviour is identical to an Section 10.2.7 [ac_top], page 328.

In contrast to the main actors it can not jump or pass an Section 8.4.19 [it_vortex], page 227, and will not sink, fall or shatter. A rotor is immortal.

Rotors do usually hunt mortal actors trying to shatter them. They accelerate by force given by the attribute '`strength`', but they limit their hunt to actors in the given '`range`'. If no attackable actor remains in this range they return to their initial position if the attribute '`gohome`' is '`true`'.

Note that in case multiple attackable actors are in range the rotor gets confused and tries to attack the center of its victims. But if you set the attribute '`attacknearest`' to '`true`' the rotor will concentrate just on the nearest victim. By adjusting the attribute '`prefercurrent`' you can instruct the rotors to prefer victims of the current active player with a certain likelihood.

Note that you need to set '`controllers`' as well as '`adhesion`' to proper values if you want a player to control a rotor directly. If a rotor is owned by a player Section 7.4.12 [fl_thief], page 178, and Section 9.5.65 [st_thief], page 308, will steal items from it.

An Section 10.2.4 [ac_marble], page 325, will temporarily transform into a rotor when it activates an Section 8.3.10 [it_drop], page 191. During the 5 seconds of transformation the actor is a real immortal rotor with the identity inclusive the '`essential_id`' of the former marble. After the period is over it transforms back to its original kind.

Attributes:

range *values*: float number; *default*: `5.0`
The distance up to which victims are hunted.

strength *values*: float number; *default*: `+10.0`
The force that drives the rotor to its victims.

gohome *values*: `true`, `false`; *default*: `true`
Behaviour of a rotor without victim in range.

attacknearest *values*: `true`, `false`; *default*: `true`
Behaviour of a rotor with multiple victims in range

prefercurrent *values*: float number in range [0.0 - 1.0]; *default*: `+0.0`
Likelihood of attack strategy. You will usually use this attribute in combination with '`attacknearest`' set to '`true`'. The Level '`Toreador`' is an example of the behavior of such rotors.

mass *values*: positive float number; *default*: `0.8`; *access*: read only

Messages: none
Variants:

ac_rotor: color = `nil`, controllers = `CTRL_NONE`, owner = `nil`

10.2.7 ac_top

A fast rotating, greenish disk like actor. It is a death bringing actor that shatters Section 10.2.4 [ac_marble], page 325s and Section 10.2.5 [ac_pearl], page 326s on contact. Its behaviour is identical to an Section 10.2.6 [ac_rotor], page 327.

In contrast to the main actors it can not jump or pass an Section 8.4.19 [it_vortex], page 227, and will not sink, fall or shatter. A top is immortal.

Tops do usually hunt mortal actors trying to shatter them. They accelerate by force given by the attribute '`strength`', but they limit their hunt to actors in the given '`range`'. If no attackable actor remains in this range they return to their initial position if the attribute '`gohome`' is '`true`'.

Note that in case multiple attackable actors are in range the top gets confused and tries to attack the center of its victims. But if you set the attribute '`attacknearest`' to '`true`' the top will concentrate just on the nearest victim. By adjusting the attribute '`prefercurrent`' you can instruct the top to prefer victims of the current active player with a certain likelihood.

Note that you need to set '`controllers`' as well as '`adhesion`' to proper values if you want a player to control a top directly. If a top is owned by a player Section 7.4.12 [fl_thief], page 178, and Section 9.5.65 [st_thief], page 308, will steal items from it.

Attributes:

range *values*: float number; *default*: `5.0`
The distance up to which victims are hunted.

strength *values*: float number; *default*: `+10.0`
The force that drives the top to its victims.

gohome *values*: `true`, `false`; *default*: `true`
Behaviour of a top without victim in range.

attacknearest *values*: `true`, `false`; *default*: `true`
Behaviour of a top with multiple victims in range

prefercurrent *values*: float number in range [0.0 - 1.0]; *default*: `+0.0`
Likelihood of attack strategy. You will usually use this attribute in combination with ‘`attacknearest`’ set to ‘`true`’. The Level ‘`Toreador`’ is an example of the behavior of such rotors.

mass *values*: positive float number; *default*: `0.8`; *access*: read only

Messages: none
Variants:

ac_top: color = `nil`, controllers = `CTRL_NONE`, owner = `nil`

10.3 Actor Features

10.3.1 Flying Actors

Ball like actors, namely Section 10.2.4 [ac_marble], page 325, and Section 10.2.5 [ac_pearl], page 326, are able to fly for short period of time if they get catapulted by some item.

Currently there are portable Section 8.3.29 [it_spring], page 205, that let actors jump on activation, static Section 8.4.14 [it_springboard], page 223, that catapult crossing actors and Section 8.4.19 [it_vortex], page 227, that catapult warping actors.

A flying actor can pass lethal grids with Section 7.4.13 [fl_water], page 178, Section 7.4.1 [fl_abyss], page 166, Section 8.4.17 [it_trap], page 226, and even laser beams. But most stones will block flying actors, even some hollow ones like Section 9.5.27 [st_grate], page 266, or Section 9.5.43 [st_oneway], page 282. But some others as Section 9.5.20 [st_door], page 258, or hollow Section 9.3 [Standard Stones], page 235, let flying actors pass.

While flying an actor can not pick up any item. But the actor can still drop items. Activation of a spring while sinking in Section 7.4.13 [fl_water], page 178, or Section 7.4.11 [fl_swamp], page 177, lets the actor jump immediately out of them and starts the sinking process from scratch anew when landing on such a floor.

11 Other Objects

11.1 Visible Others

11.1.1 ot_cannonball

A short living projectile emitted by an Section 9.5.60 [st_spitter], page 302. It is an internal object that can not be directly instantiated. It is listed here just for completeness.

11.1.2 ot_rubberband

An orange link between two objects that can apply attracting or repelling forces to them.

The two connected objects are called anchors. The attribute '`anchor1`' holds the first object's reference that must be an actor. The '`anchor2`' references the second object that can either be another actor or a stone. Both objects must exist to Section 5.13.5 [add], page 110, a rubberband to the world. If the stone sinks, breaks or is killed otherwise the rubberband will be destroyed, too.

Both anchor objects will update their attributes Section 6.1.12 [rubbers], page 129, and Section 6.1.14 [fellows], page 129, to list this rubberband and the connected object for purposes of evaluation.

The force that is applied between the objects can be configured by several attributes. Every rubberband has a natural '`length`' at which it does not apply any force to the actors. The more the rubberband is extended from this point it applies a force of the given '`strength`'. A positive strength is a natural attracting force, whereas a negative strength would repel the actors.

A rubberband that is shorter than its natural '`length`' would normally not apply any force. But this special rubber allows you to set a '`threshold`' where the rubberband starts to apply the opposite directed forces onto the actors, like a spring would do. Thus a positive '`strength`' would lead to a repelling force, a negative one to an attracting force. A rubberband with a length in between '`threshold`' and '`length`' will apply no forces. If you set the attribute '`length`' to the value `AUTOLENGTH`, the length of the rubberband is determined from the distance of its two endpoints at the time of creation.

In some cases you do want to limit the length of the rubberband. You can do this by setting '`min`' and '`max`' attributes. Actors will bounce on these limits. Do not try to use artificial large '`strength`' values instead to ensure length limits, as this could lead to extreme forces causing unexpected and unstable actor movements.

If you set '`min`' or '`max`' limits, extraordinary events like actor warping, actor resurrection, moving anchor stones or simply rubberbands that are created with an off limit length can cause trouble. When such a limit violation is detected an action is performed with a value '`false`'. You may want to kill the rubberband or react in another way by a callback function. The default handling is an application of a constant force to bring the actors back within the limits. This force value is given by Section 6.4.26 [RubberViolationStrength], page 144, and defaults to '`50.0`'. If you really need to assure that the player is not able to violate the limits any further you may need to increase this constant.

Rubberbands can be cut by Section 9.5.58 [st_scissors], page 300, by an Section 8.4.19 [it_vortex], page 227, or Section 8.4.20 [it_wormhole], page 229, with a set '`scissors`' attribute, by receiving a Section 6.2.11 [kill], page 131, message, by one of the anchors receiving a Section 6.2.13 [disconnect], page 132, message or a stone anchor that ceases to exist.

Rubberbands can be dynamically generated by Section 8.3.25 [it_rubberband], page 202, and Section 9.5.57 [st_rubberband], page 299.

Attributes:

anchor1 *values*: actor object; *default*: `nil`
Object reference or name of an actor that the rubber will be connected to. Note that the reference will be immediately evaluated and thus the actor must exist already.

anchor2 *values*: actor or stone object; *default*: `nil`
Object reference or name of an actor or a stone that the rubber will be connected to. Note that the reference will be immediately evaluated and thus the actor or stone must exist already.

strength *values*: number; *default*: `10.0`
The force strength.

length *values*: positive number or `AUTOLENGTH`; *default*: `1.0`
The natural length above which forces are applied.

threshold *values*: positive number or zero; *default*: `0.0`
The length smaller than the natural length below which inverted forces are applied.

min *values*: positive number or zero; *default*: `0.0`
The minimum length at which actors bounce.

max *values*: positive number or zero; *default*: `0.0`
The maximum length at which actors bounce.

Messages: none

Action: See Section 6.1.3 [target], page 126, See Section 6.1.4 [action], page 126
An action will be performed with value '`false`' on violation of a min or max limit. Additionally an action will be performed on behalf of Section 8.3.25 [it_rubberband], page 202, after application and creation of this rubberband with an action value of '`true`'.

11.1.3 ot_wire

A wire is a purple wire connecting two stones that transfers every stone pushing impulse from one stone to the other and vice versa. Thus both stones will move on the impulse if they are movable at all and not blocked in the direction of the impulse. The impulses may originate from an actor hitting a stone, an Section 8.3.23 [it_puller], page 200, an Section 9.5.56 [st_rotator], page 298, an Section 9.5.61 [st_stoneimpulse], page 304.

A single stone can be wired to many other stones. All these Section 6.1.14 [fellows], page 129, will move on an impulse. But the impulses will not be propagated to further stones that are wired themselves to any of the fellows. Just the direct wired stones will move.

But you can wire two stones just once. Any subsequent additional wire between two already wired stones will cut the old wire prior establishing the new one.

You can request the wires connected to a stone by the stone's Section 6.1.13 [wires], page 129, attribute. As it is tedious to evaluate both anchors, every stone supports an attribute Section 6.1.14 [fellows], page 129, that reports the connected objects.

Attributes:

anchor1 *values*: stone object; *default*: `nil`
Object reference or name of a stone that the wire will be connected to. Note that the reference will be immediately evaluated and thus the stone must exist already.

anchor2 *values*: stone object; *default*: `nil`
Object reference or name of a stone that the wire will be connected to. Note that the reference will be immediately evaluated and thus the stone must exist already.

Messages: none
Actions: none

11.2 Gadgets

11.2.1 ot_counter

A counter that switches on given thresholds. As a supplement to single switch like objects as Section 8.4.18 [it_trigger], page 226, Section 9.5.64 [st_switch], page 307, Section 9.5.36 [st_laserswitch], page 274, Section 9.5.14 [st_coinslot], page 253, Section 9.5.32 [st_key], page 271, Section 9.5.24 [st_floppy], page 264, etc. this gadget allows to react on a given number of these switches to be switched '`ON`' while the others being switched '`OFF`'.

The attribute '`state`' represents the count of switches in '`ON`' state. Due to the Section 4.4.2 [Snapshot Principle], page 58, you need to set it to the initial number of '`ON`' switches. All switches need to declare the counter gadget as their '`target`'. They all need to send a `"signal"` message as '`action`'. The counter gadget increases or decreases its count state on every received signal message thus keeping it up to date.

The gadget itself can perform actions by usage of Section 4.3.4 [Object State], page 56, dependent targets and actions.

E.g. let us assume 8 Section 8.4.18 [it_trigger], page 226s and 8 Section 9.5.7 [st_box], page 248es. Two boxes are initially on top of two triggers. A door should open as soon as the user succeeds in pushing all boxes onto the triggers.

```
ti["t"] = {"it_trigger", target="mycounter", action="signal"}
ti["b"] = {"st_box"}
ti["o"] = ti["t"] .. ti["b"]
ti["d"] = {"st_door", "mydoor"}
wo(ti, " ", {"t t t o t o t t",
             "b b b   b   b b",
     "      d   @    "})
wo:add({"ot_counter", "mycounter", state=2, target="mydoor", action_7="close", action_
```

Note that it is not sufficient to send an `"open"` message on a '`state`' count of 8, as this event occurs, when 7 boxes are on top of triggers and the last trigger is pressed by the actor itself, too. When the actor leaves the 8th trigger the gadget state decreases its state to 7 and sends a `"close"` message to the door.

Attributes:

state, *values*: numbers; *default*: 0 See Section 6.1.2 [state], page 125
The count of switches in '`ON`' state.

Messages:

signal See Section 6.2.3 [signal], page 130
Increases state on a value of '`1`', and decreases on a value of '`0`'.

Action: See Section 6.1.3 [target], page 126, See Section 6.1.4 [action], page 126
Sends an action with value '`true`' just on explicitly given Section 4.3.4 [Object State], page 56, dependent target or action attributes. No default `"toggle"` actions will be issued on other states.

11.2.2 ot_timer

This gadget can be used to trigger a delayed single or periodic events. It is nearly identical to the Section 9.5.66 [st_timer], page 308, but does neither require a grid position nor disturb the user by a pulsing animation.

Note that this is an exceptional object as its default state is '`ON`' to support the most common case of immediately running timers.

A single shot, not looping timer will send an action value of '`true`'. A looping timer will alternate the boolean action values starting with value '`true`'. You can use Section 6.1.7 [inverse], page 127, to start with a value of '`false`'.

If you stop a timer by switching it off, no further events will be performed. Restarting the timer by switching it on again will restart the timer like a new timer.

The time interval to the first event and between subsequent events can be relied on to an accuracy of 0.01 seconds. But due to performance reasons and visibility of the reactions timers should not be set to intervals below 0.1 seconds. An interval of less than 0.01 seconds is not valid for a looping timer.

Attributes:

state, *values*: `ON`, `OFF`; *default*: `ON` See Section 6.1.2 [state], page 125
An '`ON`' state timer is running. A timer in state '`OFF`' is reset and waiting for reactivation.

interval *values*: positive number; *default*: `1.0`
Number of seconds until the first and between subsequent events. The interval must be larger or equal 0.01 seconds for looping timers.

loop *values*: `true`, `false`; *default*: `true`
A looping timer will send periodic events.

Messages:

signal See Section 6.2.3 [signal], page 130
Switches on at value '`1`', and off at values '`0`'.

on See Section 6.2.4 [on], page 130
off See Section 6.2.5 [off], page 130

Action: See Section 6.1.3 [target], page 126, See Section 6.1.4 [action], page 126
The action value starts with '`true`' and alternates on every event between '`false`' and '`true`'. A timer that is reset starts again with value '`true`'

12 Libraries

Libraries do contain extensions that are not necessary for every level. By outsourcing them into separate files they do not get loaded if not used. This improves the level load time and runtime resource consumption. But as a level author you have to declare the usage of a library by an XML metadata '`dependency`' element within the Section 3.3.6 [<compatibility>], page 33, element. The necessary line of code is listed within every library description.

Some libraries contain collections of useful functions and methods. They are described in this chapter. Other libraries do contain Section 13.1 [Resolvers], page 372, and are described just there.

12.1 Basic Functions

Enigma supports most Lua 5.1 and above statements, i.e. you can freely use tables and control structures in your level, as you would expect. However, some Lua functions have been deactivated for security reasons or to ensure upwards compatibility. These are '`dofile`', '`module`', '`require`' and most or all functions of the standard libraries '`package`', '`io`' and '`os`'. You should use the Section 3.3.6 [<compatibility>], page 33-tag to include external libraries instead of '`require`', '`dofile`' or '`package`', and '`print`' for output to stdout instead of '`io`'. The '`print`' function is pretty useful for developing and debugging complex levels, but should not appear in the level's final version anymore.

Of Lua's built-in mathematical functions you may use any of the following: '`math.abs`', '`math.acos`', '`math.asin`', '`math.atan`', '`math.atan2`', '`math.ceil`', '`math.cos`', '`math.cosh`', '`math.deg`', '`math.exp`', '`math.floor`', '`math.fmod`', '`math.frexp`', '`math.huge`', '`math.ldexp`', '`math.log`', '`math.log10`', '`math.max`', '`math.min`', '`math.modf`', '`math.pi`', '`math.pow`', '`math.rad`', '`math.random`', '`math.sin`', '`math.sinh`', '`math.sqrt`', '`math.tan`', '`math.tanh`'.

All trigonometric functions use radians, you can use '`math.deg`' and '`math.rad`' to convert between radians and degrees. For the differences between '`math.mod`', '`%`', and '`math.fmod`' see Section 12.2.3 [lib.lua.mod], page 336.

While you have access to nearly all mathematical functions Lua defines, Enigma uses an own random generator, which you access via '`math.random`' with the same syntax as Lua's random generator. To ensure stability in future versions of Enigma, '`math.randomseed`' is disabled.

Please read the online manual of Lua 5.1 (`http://www.lua.org/manual/5.1/`) for more detailed information.

12.2 liblua

This library of basic extensions to the Lua language is described as of release 1.

You can load it by adding a '`dependency`' element to the Section 3.3.6 [<compatibility>], page 33, XML Metadata element as follows:

```
<el:dependency el:path="lib/liblua" el:id="lib/liblua" el:release="1" el:preload="true"
```

12.2.1 lib.lua.combine_tables

'`combine_tables`' combines all entries of a set or table of tables into one common table (i.e., it joins the subtables). As some of the subtables can have equally named entries, the first subtable has highest priority, the second subtable second priority etc.

Syntax: **lib.lua.combine_tables**(*overtable*)

lib.lua.combine_tables(*table1*, *table2*, ...)

overtable A table of tables: '`overtable = {table1, table2, ...}`'

table1, *table2*, ...
Lua tables to be joined.

Syntax Samples:

```
all_contacts = lib.lua.combine_tables(telephone_numbers, email_addresses)
```

Details: Just as groups can be joined by '`grp1 + grp2`', it can sometimes be necessary to join anonymous tables, as well. In most situations, object grouping should be used instead, but when one works with more abstract data (like names of objects instead of objects, or tables holding design information), '`combine_tables`' can be useful.

Full Example:

12.2.2 lib.lua.deep_copy

'`deep_copy`' returns a copy of its argument, where table entries are not copied as memory references (like Lua typically does), but complete (thereby called "deep copy").

Syntax: **lib.lua.deep_copy**(*source*)

source The object to be copied.

Syntax Samples:

```
a = {5}
b = a
c = lib.lua.deep_copy(a)
b[1] = 4
```

After these four commands, '`a[1]`' and '`b[1]`' will both be '`4`', but '`c[1]`' will still be '`5`'.

Details: Metatables are transferred, but not deep-copied. Userdata (like tiles and positions) is not guaranteed to be deep-copied.

Full Example:

12.2.3 lib.lua.mod

A wrapper for the modulo operation.

Syntax: **lib.lua.mod**(*value*, *modul*)

value, *modul*
Numbers. '`modul`' must be positive (non-zero).

Syntax Samples:

```
lib.lua.mod(7*7, 17)
lib.lua.mod(5.3, 1/3)
lib.lua.mod(no["marble"].x, 1)
```

Details: Lua 5.0 used '`math.mod`' as modulo operation, this function is not available in Lua 5.1 anymore, and hence not available in Enigma. Lua 5.1 provides '`%`' and '`math.fmod`'. Whereas all three operations agree on positive numbers and zero as '`value`', there are differences on negative numbers:

```
Lua 5.0:  math.mod(-1, 4) == -1
Lua 5.1:  math.fmod(-1, 4) == -1
Lua 5.1:  (-1)%4 == 3
lib.lua:  lib.lua.mod(-1, 4) == 3
```

While the Lua-own modulo functions yield results even for negative '`modul`' (with varying signs of the outcome), '`lib.lua.mod`' will raise an error if '`modul <= 0`', and the result '`r`' is otherwise guaranteed to be `0 <= r < modul`.

Full Example:

12.2.4 lib.lua.print_table

'`print_table`' is a debug command, which uses the API's '`print`' command to recursively print its argument to the standard output.

Syntax: **lib.lua.print_table**(*table*, *prefix*, *depth*)

table The table to be printed.

prefix A string which will be printed before the table as a separator. Can be '`nil`'.

depth '`nil`' in normal use, '`-1`' if you want to suppress the recursion.

Syntax Samples:

```
a = {1, [5]=2, "Hello", other_table = {x = 4, y = 5, z = "World"}}
lib.lua.print_table(a, nil, -1)
lib.lua.print_table(a, "--> ")
```

Details: '`print_table`' is recursive, i.e. a table with table as entries will call '`print_table`' again. To avoid infinite loops, '`depth`' is used internally to count the depth level of the recursion. The recursion currently stops on depth 5. Set '`depth`' to '`-1`' to stop recursion entirely.

Use '`print_table`' only for debugging and testing, it is not meant as an element of gameplay.

Full Example:

12.2.5 lib.lua.shuffle

'`shuffle`' randomly resorts its argument, a numerical table.

Syntax: *result* = **lib.lua.shuffle**(*source*)

source The table to be shuffled (only the numerical entries will be shuffled).

Syntax Samples:

```
orientations = lib.lua.shuffle({NORTH, SOUTH, EAST, WEST})
a = {1, 2, 3, "r", {"x", "y", "z"}, 4}
b = lib.lua.shuffle(a)
```

A typical result for '`b`' would be

```
b = {"r", 4, 2, {"x", "y", "z"}, 1, 3}
```

Details: The result is a permutation of the numerical entries of the source table, starting with entry 1 and ending with entry '`table.getn(`*`source`*`)`'. All other entries will simply be copied into '`result`'. All copies are shallow copies, i.e. table-valued and userdata-valued entries (like objects) are not copied, just references (pointers) to them. Use Section 12.2.2 [lib.lua.deep_copy], page 336, to create a deep copy of the shuffled table, if needed. '`result`' will use the same metatable as '`source`', and metamethods will be used during the copy and shuffling process.

Currently, '`lib.lua.shuffle`' can shuffle only tables. To shuffle groups, use the group method of the same name:

```
mygroup:shuffle()
```

Shuffling a Section 12.4 [libmap], page 344-map results in a map with shuffled rows, i.e. the x-coordinates of all tile keys are kept constant. Use Section 12.4.3 [Rotating and Mirroring Maps], page 345, to shuffle the columns.

Full Example:

12.2.6 lib.lua.to_string

'`to_string`' is a debug function. It may take anything as argument, and tries to return a sensible string describing the type and, if possible, the content of the argument.

Syntax: **lib.lua.to_string**(*arg*)

arg	The argument to be described.

Syntax Samples:

```
print(lib.lua.to_string(strange_variable))
```

Details: '`to_string`' is meant for debugging Lua code. Sometimes it happens that a variable is not what the author expected to be, and selecting the correct output method becomes try-and-error. '`to_string`' is a fast shortcut to this. It returns the content of strings, numbers, booleans, tables, positions, and groups. It distinguishes ordinary tables from Section 12.4 [libmap], page 344-maps. For objects, it returns their name and position, for position lists, it returns the total number of positions. It further recognizes nil, tile and tiles.

Use '`to_string`' only for debugging and testing, it is not meant as an element of gameplay.

Full Example:

12.3 libmath

This library of basic mathematical extensions is described as of release 1.

You can load it by adding a '`dependency`' element to the Section 3.3.6 [<compatibility>], page 33, XML Metadata element as follows:

```
<el:dependency el:path="lib/libmath" el:id="lib/libmath" el:release="1" el:preload="tru
```

It preloads automatically the library Section 12.2 [liblua], page 335.

12.3.1 lib.math.combinations

'`lib.math.combinations`' returns a table of all combinations of '`depth`' entries, each of which is chosen from '`digits`'.

Syntax: **lib.math.combinations**(*depth*, *digits*)

depth	A positive integer.
digits	A positive integer or a table with numerical entries.

Syntax Samples:

```
lib.math.combinations(2, 2)
 == { {1, 1}, {1, 2}, {2, 1}, {2, 2} }
lib.math.combinations(3, {7, 8, "a"})
 == { {7,7,7}, {7,7,8}, {7,7,"a"},
      {7,8,7}, {7,8,8}, {7,8,"a"},
      {7,"a",7}, {7,"a",8}, {7,"a","a"},
      {8,7,7}, ... }
```

Details: Mathematically, it builds the leafs of an '`#digits`'-ary tree of depth '`depth`'.

Full Example:

12.3.2 lib.math.cubic_polynomial

'`cubic_polynomial`' returns the result of the following polynomial with coefficients in '`a`':

```
a[10]*y*y*y + a[9]*x*y*y + a[8]*x*x*y + a[7]*x*x*x
  + a[6]*y*y + a[5]*x*y + a[4]*x*x + a[3]*y + a[2]*x + a[1]
```

Syntax: **lib.math.cubic_polynomial**(*a*, *x*, *y*)

a	A table with numerical entries '`a[1]`' to '`a[10]`'. The entries may be '`nil`' (i.e. missing), then they are interpreted as zero.
x, *y*	Numbers.

Syntax Samples:

```
lib.math.cubic_polynomial({1, a, b}, x, y) == a*x + b*y + 1
```

Details: You can use '`lib.math.random_vector(10, ...)`' and a modulo operation to easily form a random pattern of a floor, or choose the coefficients to your own liking. Entries in '`a`' which are not numbers are considered zero.

Full Example:

This is an excerpt from "Weirdly Wired" and demonstrates the use of '`cubic_polynomial`' inside a custom resolver to create random, but patternlike floors:

```
[...]
floors = {ti[" "], ti["a"], ti["b"], ti["c"]}
```

```
polynom = lib.math.random_vector(10, 4)

function myresolver(key, x, y)
  if key == " " then
    return floors[lib.math.cubic_polynomial(a, x, y) % (#floors) + 1]
  elseif
    [...]
  else
    return ti[key]
  end
end

w, h = wo(myresolver, " ", {
[...]
```

"Weirdly Wired" is explained in detail in section Section 5.3.2 [Weirdly Wired], page 82.

12.3.3 lib.math.cyclic_permutation

'`cyclic_permutation`' returns a random permutation (i.e. a random shuffling) of the numbers 1 to '`n`', which is cyclic: There exists a closed path from any number to any other number (see details below).

Syntax: **lib.math.cyclic_permutation**(*n*)

n A positive integer.

Syntax Samples:

```
lib.math.cyclic_permutation(#no["marbles#*"])
```

Details: A cyclic permutation is a special kind of permutation, which has only one cycle. The easiest way is to give an example for a cyclic permutation:

```
8, 1, 2, 9, 3, 7, 4, 6, 10, 5
```

We may write this as:

```
1 -> 8
2 -> 1
3 -> 2
...
```

We can now put all of these together into a sequence:

```
1 -> 8 -> 6 -> 7 -> 4 -> 9 -> 10 -> 5 -> 3 -> 2 -> 1
```

This is, the sequence creates a single cycle through all 10 numbers. This is not always possible with a general permutation.

If you need a fixpoint-free permutation, you might choose to use a cyclic permutation instead, although not every fixpoint-free permutation is cyclic.

Full Example:

If you want to connect an arbitrary number of meditation marbles with rubberbands in a cyclic manner, but otherwise randomly, you can use '`lib.math.cyclic_permutation`':

```
marbles = no["marbles#*"]
```

```
p = lib.math.cyclic_permutation(#marbles)

for j = 1, #marbles do
  wo:add({"ot_rubberband", anchor1 = marbles[j], anchor2 = marbles[p[j]]})
end
```

If you want to connect them in a linear way, you can either remove a step in the loop:

```
[...]
for j = 1, #marbles - 1 do
[...]
```

or use ‘`lib.math.permutation`’ in the following way:

```
marbles = no["marbles#*"]
p = lib.math.permutation(#marbles)

for j = 1, #marbles - 1 do
  wo:add({"ot_rubberband", anchor1 = marbles[p[j]], anchor2 = marbles[p[j+1]
end
```

12.3.4 lib.math.digits

‘`lib.math.digits`’ returns a table whose elements are the digits of ‘`number`’ in base ‘`base`’. ‘`base`’ can be a positive integer (e.g. 3 to get ternary) as well as a table (then the table entries with numerical keys will be used as digits).

Syntax: **lib.math.digits**(*number*, *base* [, *zero_is_empty*])

number A non-negative integer.

base A positive integer other than 1, or a table with numerical keys.

zero_is_empty
If `number` is zero, a table containing the zero-th digit is returned by default. If `zero_is_empty` is `true`, an empty table is returned instead.

Syntax Samples:

```
lib.math.digits(13, 2) == {1, 0, 1, 1}
lib.math.digits(15, 16) == {15}
lib.math.digits(17, 3) == {2, 2, 1}
lib.math.digits(17, {2, "b", 5}) == {5, 5, "b"}
```

The following function can be used to get a table with hexadecimal entries:

```
lib.math.digits(x, {0,1,2,3,4,5,6,7,8,9,"A","B","C","D","E","F"})
```

Details:

Full Example:

12.3.5 lib.math.manhattan_distance

‘`manhattan_distance`’ calculates the Manhattan distance between two positions ‘`pos1`’ and ‘`pos2`’, which is

```
|pos1.x - pos2.x| + |pos1.y - pos2.y|.
```

Syntax: **lib.math.manhattan_distance**(*pos1*, *pos2*)
lib.math.manhattan_distance(*x1*, *y1*, *x2*, *y2*)

pos1, *pos2* Positions (e.g. object references or tables '`{posx, posy}`'.

x1, *y1*, *x2*, *y2*
Coordinates of the positions '`pos1`' and '`pos2`', respectively.

Syntax Samples:

```
lib.math.manhattan_distance(4, 5, 3, 3)
lib.math.manhattan_distance({4, 5}, {3, 3})
lib.math.manhattan_distance(no["marble"], no["othermarble"])
```

Details: The Manhattan distance counts the minimal number of pushes necessary to push a wood stone from one position to another. Its unit balls are squares with the diagonals parallel to the x- and y-axis (rhombi).

Full Example:

12.3.6 lib.math.mark_components

'`mark_components`' calculates the connected components of a group of floors. Two floors are directly connected if their difference is within a given polist (or `NEIGHBORS_4`, by default). A table is returned holding a list of groups, each group is a complete connected component. In turn, an attribute is attached to each floor of the group which holds the number of its component. The name of this attribute can be chosen freely.

Syntax: **lib.math.mark_components**(*group*, *attribute_name* [, *neighborhood* [, *exclusive_attribute*]])

group A group of floors.

attribute_name
A non-empty string. Typically, this is the title of a user attribute, so it should start with an underscore '`_`', unless you want to feat the information directly to a non-user attribute which takes numerical values.

neighborhood
A symmetric polist (see details). Defaults to `NEIGHBORS_4`, which results in a calculation of path-connected components.

exclusive_attribute
A boolean (`false` by default) which can be set to `true`, if there is no other floor which uses an attribute named *attribute_name*.

Syntax Samples:

```
lib.math.mark_components(all_floors, "_component")
local number = #lib.math.mark_components(all_floors, "_component", NEIGHBORS
local lines = lib.math.mark_components(all_floors, "_linenumber", po(-1, 0)
```

Details: '`mark_components`' returns a Lua-table of groups, the table has natural numbers as indices counting up starting from `1`, s.t. you can access the total number of components via '#'. Each entry of the table is a subgroup of `group`, a complete connected component. The sequence of the components is determined by the sequence of the floors in `group`.

You have to choose an attribute, as it is used during the calculation. Note that all prior information saved in this attribute is lost. Also note that choosing a read-only attribute results in an error.

The chosen neighborhood has to be a symmetric polist, i.e. if it contains the position `po(x, y)` it also has to contain the position `po(-x, -y)` at some point. Mathematically speaking, we analyze the connected components of an undirected graph, not of a directed graph.

If you know that there is no other floor which uses the attribute `attribute_name`, you may set '`exclusive_attribute`' to '`true`'. This will result in a much faster algorithm.

Full Example:

12.3.7 lib.math.permutation

'`permutation`' returns a random permutation (i.e. a random shuffling) of the numbers 1 to '`n`'.

Syntax: **lib.math.permutation**(*n*)

n	A positive integer.

Syntax Samples:

```
lib.math.permutation(#no["doors#*"])
```

Details: Permutations give a simple way to randomize a level, e.g. by changing the assignment of action/target-pairs ("Which trigger to which door?").

Full Example:

12.3.8 lib.math.random_vector

'`random_vector`' returns a table of '`n`' random entries.

Syntax: **lib.math.random_vector**(*n*, *...*)

n	A non-negative integer.
...	Further arguments, which are the same as for '`math.random`': Either no further arguments, then the random numbers will be float values in '`[0,1)`', or with one additional number '`p`', then the random numbers will be integers between 1 and '`p`' (both included), or two additional numbers '`p, q`', then the random numbers will be integers between '`p`' and '`q`' (both included).

Syntax Samples:

```
lib.math.random_vector(4, 3)
```

will return a table of 4 random numbers out of {1,2,3}, and

```
lib.math.random_vector(22)
```

returns a table of 22 float values between 0.0 and 1.0 (excluding 1.0).

Details: ‘`random_vector`’ can be used in conjunction with ‘`cubic_polynomial`’ to create random patterns, see Section 12.3.2 [lib.math.cubic_polynomial], page 339, and Section 5.3.2 [Weirdly Wired], page 82.

Full Example:

12.3.9 lib.math.steps

‘`steps`’ takes a number ‘`d`’ and a table of numbers as arguments and returns the index of the first number larger or equal ‘`d`’, minus one. I.e. it classifies ‘`d`’ into the intervals given by the table, starting with zero, when ‘`d`’ is smaller than the first number in the table, one, when ‘`d`’ is larger or equal to the first, but smaller than the second number, and so on.

Syntax: **lib.math.steps**(*discriminator*, *steps*)

discriminator
A number.

steps A table of numbers.

Syntax Samples:

```
number_pairs = lib.math.steps(total_places, {2, 6, 10, 30})
```

Details: Negative and non-integer values are allowed. However, the numbers in the ‘`steps`’-table should be monotonously increasing (not necessarily strictly monotonously), as otherwise the result might be counter-intuitive.

Full Example:

```
lib.math.steps(x, {4, 8, 13})
```

returns:

```
0  if        x < 4
1  if   4 <= x < 8
2  if   8 <= x < 13
3  if  13 <= x
```

12.4 libmap

The ‘`libmap`’ gives the author more possibilities to work with API 2-maps. Up to now, a map just is a table of strings, as described in Section 5.13.1 [World Creation], page 108. With ‘`libmap`’, you can utilize maps in a more advanced way.

This library is described as of release 1.

You can load it by adding a ‘`dependency`’ element to the Section 3.3.6 [<compatibility>], page 33, XML Metadata element as follows:

<*el*:**dependency** *el*:**path**="*lib/libmap*" *el*:**id**="*lib/libmap*" *el*:**release**="*1*" *el*:**preload**="*true*"

It preloads automatically the library Section 12.2 [liblua], page 335.

We first give six task-oriented sections, then describe each function in detail.

12.4.1 Creating Maps

We start by defining a table of strings representing the level we want to write in a two-dimensional array of tile keys:

```
mypremap = {"# # # # # # # ",
                    "o t1  #   t2o ",
                    "#     #     # ",
                    "#     d2d1# # ",
                    "# @1#     @2# ",
                    "# # #     t1# ",
                    "o   d3    t3o ",
                    "# # # # # # # "}
```

To not get confused with names, in this section we'll call such a table of strings a 'premap'. We create a map (in the sense of libmap) by applying '`wo:newMap`' to it, with a default key and the premap as arguments:

```
mymap = wo:newMap("  ", mypremap)
```

The default key is saved in '`mymap`' as well, it's part of a map.

You can use

```
mymap = wo:newMap(key, height, width)
```

to define map of size '`height*width`', where every tile key is '`key`', and the default key is set to '`key`' as well. You might even omit '`height`' and '`width`', then you create a map consisting of only one character.

12.4.2 Drawing Maps

Just as we could have used the premap with '`wo`' or '`wo:drawMap`' to draw it (see Section 5.13.7 [drawMap], page 111), we can use the newly created map as well:

```
wo(resolver, mymap)
wo:drawMap(resolver, anchor, mymap)
wo:drawMap(resolver, anchor, ignore, mymap)
```

When the '`ignore`'-attribute for '`drawMap`' is omitted, the default key of '`mymap`' is used instead.

Of course you can draw the map multiple times, even from within a resolver, see Section 5.13.7 [drawMap], page 111, for a full example.

12.4.3 Rotating and Mirroring Maps

We can transform a single map simply by using one of the following commands:

```
newmap = lib.map.transform(mymap, maptransformation)
newmap = mymap ^ maptransformation
```

'`maptransformation`' can be any of the following constants:

'`MAP_IDENT`'
: No transformation.

'`MAP_ROT_CW`'
: Rotate 90 degrees clockwise.

'`MAP_ROT_180`'
: Rotate 180 degrees (i.e. a point reflection around the midpoint).

'`MAP_ROT_CCW`'
: Rotate 90 degrees counter-clockwise.

'`MAP_FLIP_HORIZONTAL`'
: Flip each horizontal line, i.e. mirror against a vertical mirror: left and right are swapped.

'`MAP_FLIP_VERTICAL`'
: Flip each vertical line, i.e. mirror against a horizontal mirror: up and down are swapped.

'`MAP_FLIP_SLASH`'
: Flip each `/`-diagonal, i.e. mirror against a `\`-mirror: upper-right and lower-left corners are swapped.

'`MAP_FLIP_BACKSLASH`'
: Flip each `\`-diagonal, i.e. mirror against a `/`-mirror: upper-left and lower-right corners are swapped.

When you apply multiple transformations, remember that their sequence matters. If you use

```
newmap = mymap ^ maptransformation1 ^ maptransformation2 ^ maptransformation3
```

then `maptransformation1` acts first on `mymap`, then comes `maptransformation2`, and `maptransformation3` is last. However, composing transformations is associative, so you can use

```
newmap = mymap ^ ((maptransformation1 ^ maptransformation2) ^ maptransformation3)
```

or

```
newmap = (mymap ^ maptransformation1) ^ (maptransformation2 ^ maptransformation3)
```

to the same effect. Keep in mind that composing transformations is by far faster than applying transformations to maps. So the first example is faster than the second. Due to Lua's sequence of evaluating operators,

```
newmap = mymap ^ maptransformation1 ^ maptransformation2 ^ maptransformation3
```

equals

```
newmap = mymap ^ (maptransformation1 ^ (maptransformation2 ^ maptransformation3))
```

and hence already is the fastest possible sequence.

For composing transformations you may use `^` as well as `*`. You can also use `maptransformation ^ n` to calculate the n-th power of `maptransformation` for any integer n. The inverse of a transformation is given by `-maptransformation`, so

```
MAP_ROT_CW * (-MAP_ROT_CW) == MAP_IDENT
```

12.4.4 Requesting and Changing Single Map Entries

Let's take a look at our example again:

```
mymap = wo:newMap("  ", {"# # # # # # # ",
                         "o t1  #   t2o ",
                         "#     #     # ",
                         "#     d2d1# # ",
                         "# @1#     @2# ",
                         "# # #     t1# ",
                         "o   d3    t3o ",
                              "# # # # # # # "})
```

It's easy to check, what kind of tile key is at position `{1,1}` (note that the upper left corner is at position `{0,0}`):

```
mymap[{1, 1}] == "t1"
```

It's similarly easy to change it. Let's say, we want to create a passage one tile right beside the second marble '`@2`', which is named '`marble2`':

```
mymap[no["marble2"] + {1,0}] = "  "
```

Note that the reference to '`marble2`' only works after the marble has been set.

Requesting and changing map entries can be used with position lists, object and group references as well.

You can replace any occurrence of a tile key '`tile1`' by '`tile2`' simply by

```
mymap:replace(tile1, tile2)
```

You can omit '`tile2`', then any occurrence of '`tile1`' will be replaced by the default key.

You can also search for positions in a map which fulfill given conditions by using '`match`', the return value is a position list. The syntax is simple:

```
mymap:match()
mymap:match(tilekey)
mymap:match({pos1, key1a, key1b, ...}, {pos2, key2a, key2b, ...}, ...)
mymap:match({{pos1, key1a, key1b, ...}, {pos2, key2a, key2b, ...}, ...})
```

The first call will return all positions of the map. The second call will return all positions with the desired `tilekey`. The third and fourth call will return all positions `x` such that `x + pos1` is one of the keys `key1a` or `key1b` or ..., and such that `x + pos2` is one of the keys `key2a`, `2b`, ..., and so on. A tile outside of the map is considered to be a default key.

The resulting position list can then be used to replace the matching tile keys:

```
mymap[mymap:match(oldkey)] = newkey
```

is equivalent to '`mymap:replace(oldkey, newkey)`' (only slower), and

```
mymap[mymap:match({po(0,0), " "}, {NEIGHBORS_4, ".", ":"})] = "."
```

will find all occurrences of '` `', which are completely surrounded by '`.`', or '`:`', or mixtures of these, and replace them by '`.`'. As all replacements are done after matching, and hence simultaneously, the newly introduced '`.`' will not participate in the matching.

12.4.5 Connecting Two Maps

Given two maps '`map1`' and '`map2`', we can glue them together horizontally by '`map1 .. map2`' as well as vertically with '`map1 + map2`'. Missing entries will be filled with the default key of the respective map, the default key of the result will be the one of '`map1`'. A simple example:

```
map1 = wo:newMap(" ", {"####",
                       "o  #",
                       "# w#",
                       "####"})
map2 = wo:newMap(".", {"#######",
                       "#w.#..#",
                       "#..D..#",
                       "#..#.w#",
                       "#######"})
map1 .. map2 == wo:newMap(" ", {"###########",
                                "o  ##w.#..#",
                                "# w##..D..#",
                                "#####..#.w#",
                                "    #######"})
map2 .. map1 == wo:newMap(".", {"###########",
                                "#w.#..#o  #",
                                "#..D..## w#",
                                "#..#.w#####",
                                "#######    "})
map1 + map2 == wo:newMap(" ", {"####   ",
                               "o  #   ",
                               "# w#   ",
                               "####   ",
                               "#######",
                               "#w.#..#",
                               "#..D..#",
                               "#..#.w#",
                               "#######"})
```

It's also possible to paste a map into another map:

```
map1:paste(map2, pos)
```

will paste '`map2`' into '`map1`' at position '`pos`' (relative to '`map1`': `{0,0}` is the upper left edge). If necessary, '`map1`' will be extended such that the whole of '`map2`' fits into it. You can use '`map1.sub`' to reduce its size again (see below) as well as to define '`map2`' as a section of another map. During the pasting, any occurrence of the default key of '`map2`' will be ignored, i.e. not drawn onto '`map1`'. You can change the default key with '`map2.defaultkey = ...`' prior to the paste command to circumvent this, or use '`map2:replace(tile)`' to replace more tile keys by the default key, such that they are not drawn as well. You can use an object group or position list for '`pos`', in this case several copies of '`map2`' will be pasted into '`map1`'. In the first case, there is no guarantee about the sequence in which the maps will be pasted into '`map1`'. In the second case, a latter entry in the position list may overwrite the result of earlier entries.

However, there's a fourth possibility: Two maps may represent two different parts of tile keys. Let's give an example to fuse two tile key layers:

```
first_char = wo:newMap(".", {"#######",
                             "#w.#..#",
                             "#..D..#",
                             "#..#.w#",
                             "#######"})
last_char  = wo:newMap(".", {"C     C",
                             " 11 22 ",
                             " 11322 ",
                             " 11 22 ",
                             "C     C"})
first_char * last_char = wo:newMap(" .", {"#C# # # # # #C",
                                          "# w1.1# .2.2# ",
                                          "# .1.1D3.2.2# ",
                                          "# .1.1# .2w2# ",
                                          "#C# # # # # #C"})
```

The default key of the fused map is the concatenation of the two original default keys. You can use a string instead of any of the two maps, in this case the whole tile key layer will consist of this string everywhere:

```
first_char = wo:newMap(".", {"#######",
                             "#w.#..#",
                             "#..D..#",
                             "#..#.w#",
                             "#######"})
first_char * "u" = wo:newMap(" u", {"#u#u#u#u#u#u#u",
                                    "#uwu.u#u.u.u#u",
                                    "#u.u.uDu.u.u#u",
                                    "#u.u.u#u.uwu#u",
                                    "#u#u#u#u#u#u#u"})
```

Fusing maps can be a mighty technique in combination with the Section 13.1.4 [res.composer], page 377- and Section 13.1.3 [res.autotile], page 374-resolvers.

A map can also be defused: '`map:defuse()`' will return a table of maps, where each map is of keylength one, holding the corresponding subkey character.

12.4.6 Other Map Tasks

You can access the default key of a map by '`mymap.defaultkey`', and change it just as easily:

```
mymap.defaultkey = ".3"
mymap:set_default_key(".3")
```

The new default key should have the same length as the old one. However, it is possible to choose a new key length as long as it fits to the map.

Width and height of a map can be accessed via '`mymap.width`' and '`mymap.height`'. However, these values can be changed only through the following commands '`mymap:extend`' and '`mymap:sub`'.

It's possible to extend a map to a given position, as long as both coordinates are non-negative:

```
mymap:extend({19, 12})
```

will extend '`mymap`' up to position '`{19,12}`'. Missing entries will be filled with the default key. If the map already covers this position, no change will be done.

If you want to check whether a position '`pos`' lies inside a map, you can use '`mymap:covers(pos)`', which returns a boolean value. Note that a map always starts in '`{0,0}`'.

'`lib.map.sub`' allows you to copy a rectangular area of a map and create a "submap" this way. '`lib.map.sub`' uses the same syntax as '`wo:drawRect`', i.e. either

```
submap = mymap:sub(pos1, pos2)
```

with '`pos1`' being the top left-hand corner and '`pos2`' the bottom right-hand corner, or alternatively

```
submap = mymap:sub(pos1, width, height)
```

to define the rectangle by its top left-hand corner and the side lengths of its area. If the bottom right-hand corner overlaps the area of '`mymap`', the resulting '`submap`' will still be just the rectangular section of '`mymap`', i.e. width and height can be less than the arguments specified. Use '`submap:extend(width, height)`' to ensure the full width and height. The default key of the submap of course is the default key of the original map.

'`lib.map.trim`' or '`mymap:trim(tilekey)`' removes all lines and columns from the North, South, East, and West that consist of `tilekey` only; it's like trimming a string from white spaces. You can omit '`tilekey`', then the default key is used instead.

'`mymap:replace_outside(tile1, tile2)`' is a kind of combination of '`replace`' and '`trim`': All occurrences of `tile1`, which are connected to the border by a path of '`tile1`', are replaced by `tile2` (or default key). Example:

```
map1 = wo:newMap(" ", {" ##########",
                       "###      ##",
                       "F# D ## # #",
                       "#       # #",
                       "########   "})
map2 = wo:newMap(" ", map1)
map1:replace_outside(" ", ".")
map2:replace_outside(" ", "#")
map2:replace_outside("#", ".")
```

will yield:

```
map1 = {".##########",
        "###      ##",
        "F# D ## #.#",
        "#       #.#",
        "########..."})
map2 = {"...........",
        "...      ..",
        "F. D ## ...",
        ".       ...",
        "..........."})
```

You can combine '`replace_outside`' with '`match`' to remove irrelevant walls:

```
map1.defaultkey = "-"
map1:replace_outside(" ")
map1[map1:match({{po(0,0), "#"}, {NEIGHBORS_4, "-", "#", "F"}})] = "-"
map1:trim()
map1.defaultkey = " "
```

will yield:

```
map1 = {"---######-",
        "--#      #",
        "F# D ## #-",
        "#       #-",
        "-#######--"})
```

Finally, you can use '`mymap:print()`' to print '`mymap`' to standard output. Similar to Section 12.2.4 [lib.lua.print_table], page 337, this is useful for debugging a level by taking a look at its maps, but should not appear in the final level. '`mymap:print()`' allows several optional arguments:

```
mymap:print(withXYCounts, left_separator, right_separator)
```

If '`withXYCounts`' is '`true`', the map is printed with coordinates on the top and on the left. '`left_separator`' and '`right_separator`' can be strings to be put between the left coordinate axis and the map, and behind the map (to analyse space characters).

12.4.7 newMap

'`wo:newMap`' takes a default key, and a premap or width and height as arguments, and returns a libmap-map.

Syntax: *mymap* = **wo:newMap**(*defaultkey*, *premap*)

mymap = **wo:newMap**(*defaultkey*, *width*, *height*)

mymap = **wo:newMap**(*defaultkey*)

defaultkey A non-empty string, which becomes the default key of the new map.

premap A table of strings. It may have lines of varying length, but each line length must be divisible by the length of the default key.

width, *height*
Positive integers. If width and height are given instead of a premap, a rectangular map consisting of the default key only is returned.

If neither a premap, nor width and height are given, a 1x1-map with the default key is returned.

Syntax Samples:
See Section 12.4.1 [Creating Maps], page 344.

Details: The syntax with neither premap nor width and height is useful in conjunction with Section 12.4.12 [Map Fusing], page 354.

A libmap-map is always rectangular. But you may use an ignore-key when you draw the map with Section 5.13.7 [drawMap], page 111, to create arbitrarily shaped areas.

If the premap is not rectangular, missing positions are set to the default key. However, each line length must be divisible by the default key's length, otherwise an error is thrown.

You may feed arbitrary tables to `wo:newMap`, but only their positive integer entries are used, all other entries are ignored. You might even skip lines, like in this example:

```
wo:newMap(" ", {[25] = "g"})
```

This will return a map of width 1 and height 25 filled with spaces, except for the last line, which will be `"g"`.

Each libmap-map is a table and can be used as a premap as well. Its default key is ignored when a libmap-map is considered as a premap. In particular, you may use `wo:newMap` to copy a libmap-map with:

```
newcopy = wo:newMap(mymap.defaultkey, mymap)
```

12.4.8 Map Entry Request

You may request and set single entries within a libmap-map, using the index-operator '`[]`'.

Syntax: *entry* = *mymap*[*posarg*]

entry = **lib.map.get**(*mymap*, *posarg*)

mymap[*posarg*] = **newentry**

lib.map.set(*mymap*, *posarg*, *newentry*)

entry, *newentry*
: Non-empty strings of the same length as the default key of `mymap`.

mymap
: A libmap-map.

posarg
: A position, object, group, position list, string, or table (interpretable as single position).

Syntax Samples:
See Section 12.4.4 [Requesting and Changing Single Map Entries], page 346.

Details: A read-access with a group or position list will return a table of all key entries at the positions in the group or position list, in their corresponding sequence. Empty groups and position lists will return empty tables.

Correspondingly, a write-access with a group or position list changes the key at each position in the group or position list to the given string.

A read-access with a string invokes a Section 5.10.1 [Positions Repository Request], page 105, to retrieve a named position, unless the string equals one of `"type"`, `"width"`, `"height"`, `"defaultkey"`, or `"keylength"`, which return the corresponding properties of the map instead.

A write-access with a string similarly is interpreted as access to a named position, unless the string equals `"defaultkey"`, see Section 12.4.13 [Map Default Keys], page 354. A write-access to a non-existing position throws an error.

You may request any position outside of the scope of the map, even with negative coordinates. If you do so, the default key is returned. This accounts for non-existing positions as well (for example positions of items in the inventory, or the position of a string which doesn't describe a named position).

If you try to set an entry to a position with a negative coordinate an error is returned. However, if you use non-negative coordinates outside of the scope of the map, the map is subsequently extended to the new position, setting the default key as entry where necessary.

Floating-point coordinates are always rounded to a grid position (see Section 5.5.8 [Position Grid Rounding], page 92).

12.4.9 Map Transformation

You may transform any libmap-map according to the eight map transformation constants given in Section 12.4.3 [Rotating and Mirroring Maps], page 345.

Syntax: *newmap* = *mymap*^*maptransformation*

newmap = **lib.map.transform**(*mymap*, *maptransformation*)

mymap, *newmap*
: libmap-maps.

maptransformation
: One of the following eight constants: `MAP_IDENT`, `MAP_ROT_CW`, `MAP_ROT_180`, `MAP_ROT_CCW`, `MAP_FLIP_HORIZONTAL`, `MAP_FLIP_VERTICAL`, `MAP_FLIP_SLASH`, `MAP_FLIP_BACKSLASH`.

Syntax Samples:
See Section 12.4.3 [Rotating and Mirroring Maps], page 345.

Details: As map transformations can be composed with '^', it is possible to combine several transformations without brackets; it's only important to always have the map on the left side of the '^'-sign:

```
newmap = mymap ^ MAP_ROT_CW ^ MAP_FLIP_HORIZONTAL
```

However, each such combination can equally well be expressed with a single constant.

After a transformation, height and width of a map might have swapped.

12.4.10 Map Horizontal Concatenation

You may glue libmap-maps one after another in horizontal direction using '`..`'. Note the similarity to the meaning of '`..`' in the context of strings to remember its meaning in contrast to '+' (see Section 12.4.11 [Map Vertical Concatenation], page 354).

Syntax: *newmap* = *mymap1* **..** *mymap2*

newmap = **lib.map.concat_horizontally**(*mymap1*, *mymap2*)

mymap1, *mymap2*, *newmap*
: libmap-maps.

Syntax Samples:
See Section 12.4.5 [Connecting Two Maps], page 347.

Details: The upper-left corner of the second map is set beneath the upper-right corner of the first, i.e. the bottom lines of the maps are aligned. If you want to align them in another way, you may first vertically concat a map of suitable height to the second (or first) map, like in this example:

```
newmap = mymap1 .. (wo:newMap(" ", 1, 13) + mymap2)
```

The default key of the new map is the default key of the first map. Any missing position to gain a rectangular map is subsequently set to this default key.

12.4.11 Map Vertical Concatenation

You may glue libmap-maps on top of each other in vertical direction using '`+`'. Compare with the meaning of '`..`' (see Section 12.4.10 [Map Horizontal Concatenation], page 353).

Syntax: *newmap* = *mymap1* `+` *mymap2*

newmap = **lib.map.concat_vertically**(*mymap1*, *mymap2*)

mymap1, *mymap2*, *newmap*
libmap-maps.

Syntax Samples:
See Section 12.4.5 [Connecting Two Maps], page 347.

Details: The upper-left corner of the second map is set below the lower-left corner of the first, i.e. the left borders of the maps are aligned. If you want to align them in another way, you may first horizontally concat a map of suitable width to the second (or first) map, like in this example:

```
newmap = mymap1 + (wo:newMap(" ", 13, 1) .. mymap2)
```

The default key of the new map is the default key of the first map. Any missing position to gain a rectangular map is subsequently set to this default key.

12.4.12 Map Fusing

You may fuse libmap-maps in the way described in Section 12.4.5 [Connecting Two Maps], page 347, by interpreting the two keys of the two maps at a position as parts of a combined (fused) key at this position.

Syntax: *newmap* = *mymap1* `*` *mymap2*

newmap = **lib.map.fuse**(*mymap1*, *mymap2*)

mymap1, *mymap2*, *newmap*
libmap-maps.

Syntax Samples:
See Section 12.4.5 [Connecting Two Maps], page 347.

Details: Missing keys in one map are replaced by the default key of this map.

The default key of the result is the concatenation of the default key of the first map with the default key of the second map (as expected).

The inverse of the fusing operation is given by Section 12.4.16 [lib.map.defuse], page 357.

One of the maps is allowed to be a string, which is then interpreted as a 1x1-map with the given string as default key. The result of the fusing process then is that each tile key is concatenated with the given string.

12.4.13 Map Default Keys

A libmap-map always includes a default key, which is used in various places throughout the library. It is the placeholder whenever a key out of scope of the map is requested, or when Section 5.13.7 [drawMap], page 111, or `wo` (see Section 5.13.1 [World Creation], page 108) are invoked without a default or ignore key. Hence, it is sometimes necessary to retrieve or change the default key of a map.

Syntax: *defaultkey* = *mymap*.**defaultkey**

defaultkey = *mymap*["**defaultkey**"]

keylength = *mymap*.**keylength**

keylength = *mymap*["**keylength**"]

mymap.**defaultkey** = *newkey*

mymap["**defaultkey**"] = *newkey*

mymap:**set_default_key**(*newkey*)

lib.map.set_default_key(*mymap*, *newkey*)

defaultkey, *newkey*
A non-empty string.

mymap A libmap-map.

keylength A positive integer, which equals the length of the default key.

Syntax Samples:
See Section 12.4.6 [Other Map Tasks], page 349.

Details: It typically makes sense to change the default key of a map, when two or more keys can be equally well thought of as being "default". Such an example occurs during the import of Sokoban levels: While the canonical default key would be the key of the inner free tiles, it is temporarily set to the key of the outer area to allow a simple matching and trimming. It is then set back again:

```
local map = lib.import.level_to_map(level, "\n", " ")
map:replace("_")
map:replace("-")
map:replace_outside(" ", "-")
-- Remove redundant walls by outside:
-- A wall is redundant, if it is surrounded by "-" or "#".
-- In this case, it can be replaced by "-".
map.defaultkey = "-"
map[map:match({{po(0,0), "#"}, {NEIGHBORS_8, "-", "#"}})] = "-"
map = map:trim()
map.defaultkey = " "
```

See Section 12.4.18 [lib.map.match], page 358, and Section 12.4.24 [lib.map.trim], page 363, for details on their use of default keys.

The keylength of a map can be read, but not written. To change the keylength, a new default key has to be assigned. On the other hand, it is possible to change the default key to a key of different length; however, this rarely makes sense, as each line will be reinterpreted, and the width of the map changes. Still, the width has to fit to the new keylength, otherwise an error is thrown.

If you want to change the keylength without reinterpreting each line, you should instead fuse or defuse the map (see Section 12.4.12 [Map Fusing], page 354, Section 12.4.16 [lib.map.defuse], page 357). Section 12.4.7 [newMap], page 351, allows this quite easily:

```
extendedmap = mymap * wo:newMap(" ")
restrictedmap = (mymap:defuse())[1] * (mymap:defuse())[3]
```

12.4.14 Map Width and Height

A libmap-map always includes its width and height. These determine for example the exact position of the second map during a concatenation (see Section 12.4.5 [Connecting Two Maps], page 347).

Syntax: *width* = *mymap*.**width**

width = *mymap*["**width**"]

height = *mymap*.**height**

height = *mymap*["**height**"]

width, *height*
: Positive integers.

mymap
: A libmap-map.

Details: See also Section 12.4.6 [Other Map Tasks], page 349.

It is not possible (and rarely necessary) to directly change width and height of a map. Instead, you might use Section 12.4.17 [lib.map.extend], page 357, to extend a map to a given position, Section 12.4.23 [lib.map.sub], page 362, to retrieve a rectangular part of a map, or Section 12.4.24 [lib.map.trim], page 363, to remove unused lines and columns from the map.

Note that width and height are not invariant. They change with many operations, like transformations, concatenations or setting a key outside the former scope of a map.

Also note that the upper-left corner of a map has coordinates `{0, 0}`, so the lower-right corner is `{width - 1, height - 1}`.

12.4.15 lib.map.covers

`covers` checks whether a position is within the scope of a map.

Syntax: *result* = *mymap*:**covers**(*position*)

result = **lib.map.covers**(*mymap*, *position*)

result
: A boolean value: `true`, if *position* is within the rectangle of grids spanned by `(0,0)` and `(mymap.width - 1, mymap.height - 1)`, otherwise `false`.

mymap
: A libmap-map.

position
: A positional value (position or table with two entries).

Syntax Samples:

```
if map1:covers(po(no["mycoin"]) - po(no["anchor1"])) then
    wo(no["mycoin"]) = ti["-"]
end
```

Details: Floating-point positions are handled as expected, i.e. the position of a marble which is on a grid corresponding to the map lets `cover` return `true`.

Remember to subtract the anchor of an already drawn map to get the correct information when you use positions of the level world.

12.4.16 lib.map.defuse

`defuse` returns a table of maps of keylength one, which correspond to the first, second, n-th character of each key at each position, respectively.

Syntax: *result* = *mymap*:**defuse**()

result = **lib.map.defuse**(*mymap*)

result	A non-empty table with maps as entries at integer positions. There are as many maps as the keylength of `mymap`.
mymap	A libmap-map.

Full Example:

Given the following map,

```
mymap = wo:newMap(" .", {"#C# # # # # #C",
                         "# w1.1# .2.2# ",
                         "# .1.1D3.2.2# ",
                         "# .1.1# .2w2# ",
                         "#C# # # # # #C"})
```

`mymap:defuse()` will return a table

```
result = {map1, map2}
```

containing the following two maps:

```
map1 = wo:newMap(".", {"#######",
                       "#w.#..#",
                       "#..D..#",
                       "#..#.w#",
                       "#######"})
map2  = wo:newMap(".", {"C     C",
                        " 11 22 ",
                        " 11322 ",
                        " 11 22 ",
                        "C     C"})
```

Details: The default keys of the defused maps are the single characters of the default key, in corresponding sequence.

The inverse of defusing is Section 12.4.12 [Map Fusing], page 354.

12.4.17 lib.map.extend

`extend` changes a map in-place such that it covers a given position. If the position already is within the scope of the map, nothing happens.

Syntax: *mymap*:**extend**(*position*)

lib.map.extend(*mymap*, *position*)

mymap	A libmap-map.

position A positional value (position, table with two entries, valid object, or string).

Syntax Samples:

```
mymap:extend(po(no["mycoin1"]) - po(no["anchor1"]))
mymap:extend("secondanchor")
```

Details: Negative coordinates are silently ignored. However, if the other coordinate makes sense, the map might still get extended.

Floating-point coordinates are rounded to a grid position (see Section 5.5.8 [Position Grid Rounding], page 92).

12.4.18 lib.map.match

You may use `match` to search for patterns or keys within a map. `match` then returns a position list of grid positions.

Syntax: *result* = *mymap*:**match**()

result = *mymap*:**match**(*tilekey*)

result = *mymap*:**match**(*conditionlist*)

result = *mymap*:**match**({conditionlist})

result = **lib.map.match**(*mymap*, *conditionlist*)

result The position list of all matched positions.

mymap A libmap-map.

conditionlist = condition, condition, ...
A list of conditions. A position is matched if and only if all conditions of the *conditionlist* are matched.

condition = {*positionlist*, *tilekey*, *tilekey*, ...}
A position `pos` is matched by this condition if and only if for each position `relativepos` in `positionlist` the tilekey `mymap[pos + relativepos]` equals one of the tilekeys in the list. If `pos + relativepos` is outside the scope of *mymap*, its tilekey is the default key.

tilekey Non-empty string of the same length as the default key of `mymap` (no wildcards).

positionlist
A single relative position or a position list of relative positions.

Full Example:

Given the following map,

```
mymap = wo:newMap(" ", {"#####",
                        "#w# #",
                        "# D #",
                        "# #w#",
                        "#####"})
```

`mymap:match("#")` will return a position list of all walls `"#"`, it is identical to `mymap:match({po(0, 0), "#"})` and `mymap:match({{po(0, 0), "#"}})`.

We may search for all positions `pos` which are between two walls with:

```
result = mymap:match({po(-1, 0), "#"}, {po(1, 0), "#"})
```

The two positions `po(-1, 0)` and `po(1, 0)` are relative to the returned position. This returns a position list including positions like the wall at `{1,0}` (which indeed is between two walls at `po(1, 0) + po(-1, 0)` and `po(1, 0) + po(1, 0)`), but also `{1,1}`. If we want to exclude walls at our position, we have to give all other keys instead:

```
result = mymap:match({po(-1, 0), "#"}, {po(1, 0), "#"}, {po(0, 0), "w", " ",
```

Finally, `mymap:match()` will return all positions of the map, i.e. a position list with all positions between `{0,0}` and `{mymap.width - 1, mymap.height - 1}`.

See also Section 12.4.4 [Requesting and Changing Single Map Entries], page 346.

Details: You can, but need not pack the condition list `match` into a single table. This possibility exists to easily work with automatically generated condition lists, but should be avoided in other cases due to readability.

The result of `match` is sorted primarily vertical, and secondarily horizontal, i.e. a typical result would be:

```
po(1, 1) .. po(1, 3) .. po(1, 4) .. po(2, 2) .. po(2, 3) .. po(5, 1)
```

If you feed the position list back into a replacing command, like in

```
mymap = wo:newMap(" ", {"####",
                        "#  #",
                        "####"})
mymap[mymap:match({NEIGHBORS_8, "#"})] = "#"
```

remember that the newly added changes could not be respected by the `match`; so in the above example, the match returns an empty position list and no tilekey is subsequently replaced.

Floating-point coordinates are rounded to a grid position (see Section 5.5.8 [Position Grid Rounding], page 92).

12.4.19 lib.map.paste

`paste` copies a map into another map at a given position. This command works in-place, i.e. the receiving map is changed, instead of returning a new map.

Syntax: *map1*:**paste**(*map2*, *position*)

lib.map.paste(*map1*, *map2*, *position*)

map1	The libmap-map to receive the copy.
map2	The libmap-map which is to be copied into `map1`.
position	A positional value (position, table with two entries, valid object, position list, group, or string). The upper-left position `{0, 0}` of `map2` is inserted at this position (or these positions) into `map1`.

Full Example:

```
map1 = wo:newMap(" ", {"#######",
                       "#w #  #",
                       "#  D  #",
                       "#  # w#",
                       "#######"})
map2 = wo:newMap(".", {"F.E",
                       "E.E"})
```

In this situation, `map1:paste(map2, po(1, 1) .. po(5, 3))` will change map1 into:

```
{"####### ",
 "#F E  # ",
 "#E E  # ",
 "#  # F#E",
 "#####E#E"}
```

Details: The receiving map will be extended with its default key as necessary.

Each tilekey of the copied map which equals its default key will be ignored during the pasting process.

Floating-point coordinates are rounded to a grid position (see Section 5.5.8 [Position Grid Rounding], page 92).

If a part of a map is to be copied to a position with negative coordinates, an error is thrown. However, if this part is to be ignored anyway (because it is the default key), then the negative coordinate is silently ignored. If for example we have

```
map1 = wo:newMap(" ", {"#######",
                       "#w #  #",
                       "#  D  #",
                       "#  # w#",
                       "#######"})
map2 = wo:newMap(".", {".FE",
                       ".EE"})
```

then `map1:paste(map2, po(-1, 0))` will change map1 into

```
{"FE#####",
 "EE #  #",
 "#  D  #",
 "#  #  #",
 "#######"}
```

while `map1:paste(map2, po(0, -1))` throws an error.

A map can be pasted multiple times into another map by providing a position list or object group. The sequence of pastings is then given by the sequence of the list or group, so the pasting at the second entry might overwrite the changes done by the first entry.

12.4.20 lib.map.print

`print` prints a map to standard output. You may use this command for debugging purposes, or to support development or translation of a level, but it should not be used in the released form of a level.

Syntax: *mymap*:**print**([*withXYCounts* [, *left_separator* [, *right_separator*]]])

lib.map.print(*mymap* [, *withXYCounts* [, *left_separator* [, *right_separator*]]])

mymap A libmap-map.

withXYCounts
A boolean value, `false` by default.

left_separator, *right_separator*
Strings to be printed on the left and on the right side of the map, empty strings by default.

Full Example:

```
mymap = wo:newMap(" ", {"#######",
                        "#w #  #",
                        "#  D  #",
                        "#  # w#",
                        "#######"})
```

Then `mymap:print(true, " -> ", "|")` prints the following to standard output:

```
   -> 0123456|
 0 -> #######|
 1 -> #w #  #|
 2 -> #  D  #|
 3 -> #  # w#|
 4 -> #######|
```

Details: If you use maps wider than ten times its keylength, the x-count will show only the last digits of the x coordinate.

If you want to insert lines between the columns, you can fuse the map with your desired character, like in `(mymap * "|"):print(...)`.

You can actually use `print` to generate a map for a level file if you provide appropriate separators:

```
mymap:print(false, "    \"", "\",")
```

12.4.21 lib.map.replace

`replace` replaces all occurrences of a single tile key in a map in-place with another tile key.

Syntax: *mymap*:**replace**(*oldkey* [, *newkey*])

lib.map.replace(*mymap*, *oldkey* [, *newkey*])

mymap A libmap-map.

oldkey A non-empty string of the same length as `mymap`'s default key.

newkey	A non-empty string of the same length as `mymap`'s default key, which is the replacement for `oldkey`. The default replacement key is the default key itself.

Syntax Samples:

```
mymap:replace("#", "-")
```

will change `mymap` in such a way that each `"#"` is replaced by `"-"`. If `"-"` is omitted, each `"#"` is replaced by the default key instead.

Details: '`mymap:replace(tile1, tile2)`' is equivalent to

```
mymap[mymap:match(tile1)] = tile2 or mymap.defaultkey
```

but faster, because no position list is constructed in between (see Section 12.4.18 [lib.map.match], page 358).

See also Section 12.4.22 [lib.map.replace_outside], page 362, and Section 12.4.4 [Requesting and Changing Single Map Entries], page 346.

12.4.22 lib.map.replace_outside

`replace_outside` is a very specialized command, which is used to replace all occurrences of a tile key which are connected to the border of the map by a path of this tile key with another tile key. The replacement is done in-place, i.e. no new map is created or returned.

Syntax: *mymap*:**replace_outside**(*oldkey* [, *newkey*])

lib.map.replace_outside(*mymap*, *oldkey* [, *newkey*])

mymap	A libmap-map.
oldkey	A non-empty string of the same length as `mymap`'s default key.
newkey	A non-empty string of the same length as `mymap`'s default key, which is the replacement for `oldkey`. The default replacement key is the default key itself.

Syntax Samples:

See Section 12.4.6 [Other Map Tasks], page 349.

Details: `replace_outside` shows similarities with Section 12.4.21 [lib.map.replace], page 361, and Section 12.4.24 [lib.map.trim], page 363. It is the only universal way to handle the area near the border of a map, and can be combined with Section 12.4.18 [lib.map.match], page 358, and Section 12.4.24 [lib.map.trim], page 363, to show its full potential.

Because of its recursive nature, old and new tile key must be different; in contrast to the situation of Section 12.4.21 [lib.map.replace], page 361, identical tile keys are not silently ignored, but throw an error message.

12.4.23 lib.map.sub

`sub` returns a copy of a rectangular section of a map as a new map.

Syntax: *submap* = *mymap*:**sub**(*upperleft*, *lowerright*)

submap = *mymap*:**sub**(*upperleft*, *width*, *height*)

submap = **lib.map.sub**(*mymap*, *upperleft*, *lowerright*) *submap* = **lib.map.sub**(*mymap*, *upperleft*, *width*, *height*)

submap A libmap-map, the rectangular section of `mymap`.

mymap A libmap-map.

upperleft, *lowerright*
Positional values (position, valid object, table with two entries, or name of a named position.

width, *height*
Positive integers.

Syntax Samples:
See Section 12.4.6 [Other Map Tasks], page 349.

Details: If the bottom right-hand corner overlaps the area of `mymap`, the resulting `submap` will still be just the rectangular section of `mymap`, i.e. width and height can be less than the arguments specified. Use `submap:extend(width, height)` to ensure the full width and height.

Floating point positions are rounded to grid positions, and the lower-right corner may not have coordinates less than those of the upper-left corner, otherwise an error is thrown.

The default key of the submap is the default key of the original map.

The upper-left corner of the submap of course is `{0,0}`, i.e. the coordinates are shifted accordingly.

12.4.24 lib.map.trim

`trim` returns the smallest rectangular section of a map as new map such that its border consists of a given tile key only, i.e. it trims the original map from the North, East, South, and West.

Syntax: *trimmedmap* = *mymap*:**trim**([*tilekey*])

trimmedmap = **lib.map.trim**(*mymap* [, *tilekey*])

trimmedmap
A libmap-map, the trimmed copy of `mymap`.

mymap A libmap-map.

tilekey A non-empty string of the same length as the default key. If omitted, the default key is used instead.

Full Example:
With the following map:

```
mymap = wo:newMap(" ", {"#######",
                        "#w #  #",
                        "#  D  #",
                        "#  # w#",
                        "#######"})
```

Trimming with '`mymap:trim()`' will return just a copy of the original map, but '`mymap:trim("#")`' returns a map as follows:

```
{"w #  ",
          "  D  ",
          "  # w"})
```

Details: The default key of the trimmed map is the default key of the original map.

If the original map consists of the trimmed key only, then `trim` returns a 1x1-map with the trimmed key as only entry, and the default key of the original map.

12.4.25 Map Transformation Index and MAP_ALL

All eight transformation constants (see Section 6.3.15 [map read directions], page 136, Section 12.4.3 [Rotating and Mirroring Maps], page 345, Section 12.4.9 [Map Transformation], page 353) are additionally packed into the table `MAP_ALL`, so a simple call to `ipairs(MAP_ALL)` can iterate over all of them. `MAP_ALL` is provided without need to load libmap.

Each transformation offers the field `"index"`, which returns the number at which the transformation appears in `MAP_ALL`. libmap is not needed to use `"index"` either.

Syntax: **MAP_ALL** = {**MAP_IDENT**, **MAP_ROT_CW**, **MAP_ROT_180**, **MAP_ROT_CCW**, **MAP_FLIP_BACKSLASH**, **MAP_FLIP_HORIZONTAL**, **MAP_FLIP_SLASH**, **MAP_FLIP_VERTICAL**}

transformation_index = *maptransformation*.**index**

transformation_index
: An integer between 1 and 8.

maptransformation
: A map transformation.

Syntax Samples:

```
MAP_ALL[MAP_ROT_CW.index] == MAP_ROT_CW
```

Details: You may not safe map transformations as attributes of objects, for example the following will throw an error:

```
no["stone_a"]["_mytrafo"] = MAP_ROT_CCW
```

Instead, you have to use `index` and retrieve the correct transformation from `MAP_ALL`:

```
no["stone_a"]["_mytrafo"] = MAP_ROT_CCW.index
...
oldtrafo = MAP_ALL[no["stone_a"]["_mytrafo"]]
```

12.4.26 Map Transformation Composition and Powers

The transformation constants (see Section 6.3.15 [map read directions], page 136, Section 12.4.3 [Rotating and Mirroring Maps], page 345, Section 12.4.9 [Map Transformation], page 353) can be composed according to their true operation on a map, as soon as libmap is loaded. The composition is returned by the operations '`*`' and '`^`'.

Syntax: *composition* = *maptransformation1* `*` *maptransformation2*

composition = *maptransformation1* `^` *maptransformation2* *composition* = **lib.map.transformation_compose**(*maptransformation1*, *maptransformation2*)

composition = **lib.map.transformation_power**(*maptransformation1*, *maptransformation2*)

power = *maptransformation* ^ *exponent*

power = **lib.map.transformation_power**(*maptransformation*, *exponent*)

composition
: The result of composing two map transformations.

maptransformation1, *maptransformation2*, *maptransformation*
: Map transformations.

power The `exponent`-th power of `maptransformation` (again a map transformation).

exponent An integer.

Syntax Samples:

```
new_transformation = (MAP_ROT_CW * MAP_FLIP_HORIZONTAL) ^ 2
another_transformation = (new_transformation ^ MAP_ROT_180) ^ (-1)
```

Details: The eight possible map transformations are the elements of a mathematical group, the dihedral group of order 8. Composition of any two map transformations therefore yields another one of the eight map transformations. An n-th power of a map transformation is the composition of n such transformations. In the case of the dihedral group, any 4-th power returns the original element. This fact is applied during calculating a power, so it doesn't make a difference to the performance when you use large numbers as exponents.

Composing with `MAP_IDENT` doesn't change the value; it's like adding zero to a number, or multiplying with one.

Keeping to group theoretic notions, the operation '`^`' between map transformations should denote conjugation instead of composition. Instead of this, it is chosen to be synonymous to '`*`' to allow for associativity of expressions like:

```
new_map = old_map ^ MAP_ROT_CCW ^ MAP_FLIP_VERTICAL
```

(Remember that Lua evaluates '`^`' from the right.)

The inverse can be calculated with a power to `-1`, but also by '`-`', see Section 12.4.27 [Map Transformation Inverse], page 365.

12.4.27 Map Transformation Inverse

The transformation constants (see Section 6.3.15 [map read directions], page 136, Section 12.4.3 [Rotating and Mirroring Maps], page 345, Section 12.4.9 [Map Transformation], page 353) have proper inverses, i.e. map transformations that reverse their action. These inverse transformations are returned by '`-`'.

Syntax: *inverse* = `-`*maptransformation*

inverse = **lib.map.transformation_inverse**(*maptransformation*)

inverse The inverse map transformation of `maptransformation`.

maptransformation
A map transformation.

Syntax Samples:

```
reverse_transformation = -MAP_ROT_CW
```

In this case, `reverse_transformation` equals `MAP_ROT_CCW`, because their composition `MAP_ROT_CW * MAP_ROT_CCW` equals the trivial transformation (or identity) `MAP_IDENT`.

Details: The eight possible map transformations are the elements of a mathematical group, the dihedral group of order 8. The inverse of any map transformation therefore yields another one of the eight map transformations. Composition of any map transformation with its inverse results in `MAP_IDENT`. However, within the dihedral group of order 8, only two elements have inverses that are not their own inverses: the two rotations by 90 degrees.

Keeping to group theoretic notions, the inverse is denoted by '`^ (-1)`', which works just as well(see Section 12.4.26 [Map Transformation Composition and Powers], page 364).

12.4.28 Random Map Transformations

libmap provides the function `lib.map.random_transformation()` to pick one of the eight transformations by random.

Syntax: *randomtransformation* = **lib.map.random_transformation**()

randomtransformation
A map transformation, randomly chosen from `MAP_ALL`.

Syntax Samples:

```
wo:drawMap(ti, po(5, 4), mymap, lib.map.random_transformation())
```

Details: When you use random map transformations, remember that four out of the eight map transformations switch height and width of the map they are applied to.

12.5 libimport

libimport is dedicated to parse level files of other games or formats and typically returns Section 12.4 [libmap], page 344-maps. In this context, the word "level" refers to a string, representing a level of the other game. A "monolevel" is a string which holds a single level, but also additional information, like titles or author names. A "multilevel" is a string composed of one or more monolevels. A "map" is a map in the libmap-sense, i.e. an Enigma level.

Apart from the following functions, lib.import includes the minor routines '`lib.import.string_replace`', which is a wrapper for `string.gsub`, and '`lib.import.string_remove_multiples`', which removes multiple occurrences of a string in another string.

This library is described as of release 1.

You can load it by adding a '`dependency`' element to the Section 3.3.6 [<compatibility>], page 33, XML Metadata element as follows:

```
<el:dependency el:path="lib/libimport" el:id="lib/libimport" el:release="1" el:preload=
```

It preloads automatically the libraries Section 12.4 [libmap], page 344, and Section 12.2 [liblua], page 335.

12.5.1 lib.import.unpack_multilevel

'`unpack_multilevel`' extracts a level from a multilevel string. For this, it needs a regexp describing a single level line.

Syntax: **lib.import.unpack_multilevel**(*multilevel*, *sublevel_number*, *format*)

multilevel A multilevel string.

sublevel_number
The number of the level in `multilevel` to be extracted. First level is '`1`'. If `nil`, '`1`' is taken as default.

format A string referencing an entry in '`lib.import.line_regexp`'. Currently, only '`sokoban`' and '`wanderer`' are supported. But you can add further entries to '`lib.import.line_regexp`' if necessary.

Syntax Samples:

```
level_four = lib.import.unpack_multilevel(large_string, 4, "sokoban")
```

Details: A level extracted with `unpack_multilevel` has still to be converted into a format Enigma understands. A level is a string, and lines of the level are to be determined by line endings, which can be quite different. In contrast to this, an Enigma map is a table of strings, with each line in a separate entry of the table. Hence, at least the line endings have to be dealt with.

12.5.2 lib.import.uncompress_rle

'`uncompress_rle`' takes a string as argument and returns a decoded version without run-length encoding.

Syntax: **lib.import.uncompress_rle**(*level*, *attribs*)

level A level string.

attribs A table containing further parameters. Currently, the only supported parameter is '`error_on_multiple`'.

Syntax Samples:

```
uncompressed = lib.import.uncompress_rle(compressed, {error_on_multiple = "\
```

Details: Levels typically include long lines of repeating characters, like walls or spaces. To save space, these are sometimes counted and replaced by the total number and a single example of the character. This is called "run-length encoding", or RLE.

```
"############  A #####BB#" compresses to "12#2 A5#2B#"
```

However, some characters don't make sense to be repeated, like line endings. To return an error when trying to repeat a line ending during decompression, you can hand a string to the attribute '`error_on_multiple`'. Any character in this string is then forbidden to be repeated. Remember that the '`new line`'-character is represented by '`\n`' in Lua.

12.5.3 lib.import.level_to_map

'`level_to_map`' breaks a level string down into a table of strings, which is then converted into a Section 12.4 [libmap], page 344-map.

Syntax: **lib.import.level_to_map**(*level*, *line_ending*, *default_key*)

level A level string.

line_ending
A string describing a single line ending. Default: '`\n`'

default_key
The default key of the returned map. Default: '` `'

Syntax Samples:

```
mymap = lib.import.level_to_map(level, "|", " ")
```

Details: Multiple line endings are interpreted as multiple lines (of which the last lines are filled with the default key).

Make sure that the last line of the level ends in a proper line ending, and only one line ending. Otherwise, the returned map will be too short or too long.

12.5.4 lib.import.map_sokoban

'`map_sokoban`' takes a Sokoban multilevel as argument, and returns a beautified Section 12.4 [libmap], page 344-map.

Syntax: **lib.import.map_sokoban**(*multilevel*, *sublevel_number*, *keylength_one*)

multilevel A multilevel string.

sublevel_number
The number of the level to be extracted. First level is '`1`'. Default: '`1`'

keylength_one
A boolean value. If `false`, the returned map has keylength two. Otherwise, it has keylength one. Default: '`false`'

Syntax Samples:

```
map_four = lib.import.map_sokoban(multilevel, 4, true)
```

Details: Sokoban level files can be very different - they can use run-length encoding and multilevel files. Sometimes, '`|`' is used as line ending instead of or even together with '`\n`'. '` `', '`_`' and '`-`' can all represent space. Sometimes, the outside is filled with '` `', then again with '`#`'. Finally, line width can vary. We use a slightly generalized version, to include chessoban levels. Allowed characters are:

`- _ space`	`space`
`#`	`wall`
`.`	`goal`

`$ *`	`box, box with goal`
`n N`	`st_chess, st_chess with goal`
`@ +`	`player, player with goal`

The returned map will use ‘ ’ for inside space, ‘-’ for outside space, default key is ‘ ’.

If you chose ‘`keylength_one = true`’, the returned map will use the characters as described above. Otherwise, the returned map will have keylength two, and the characters ‘`*`’, ‘`N`’, and ‘`+`’ are resolved into ‘`$.`’, ‘`n.`’, and ‘`@.`’ respectively, while the other keys become ‘ ’, ‘`- `’, ‘`# `’, ‘` .`’, ‘`$ `’, ‘`n `’, and ‘`@ `’. You can then use Section 13.1.4 [res.composer], page 377, to easily draw your map.

Remember that the returned map uses the inner space ‘ ’ or ‘ ’ as default key. Hence, if you want to paste the map into another one (Section 12.4.5 [Connecting Two Maps], page 347), you will have to switch the default key to ‘`-`’ or ‘`- `’ in beforehand to yield a good result.

12.5.5 lib.import.map_wanderer

‘`map_wanderer`’ takes a Wanderer monolevel as argument, and returns a Section 12.4 [libmap], page 344-map. Note that Enigma does not yet have the necessary game objects to simulate Wanderer.

Syntax: **lib.import.map_wanderer**(*monolevel*)

monolevel A monolevel string.

Syntax Samples:

```
mymap = lib.import.map_wanderer(monolevel)
```

Details: Wanderer is a game originally created by Steven Shipway in 1988. Wanderer level files are uncompressed monolevels with fixed width. The level itself is followed by a short description (title/author/email) in a single line or a line of ‘`#`’. Last line optionally is a number. A Wanderer level knows the following characters (taken from Wanderer's editor):

`: _ #`	`earth, rock, indestructible rock`
`* - space`	`treasure, alternative space, space`
`O < > ^`	`falling boulder, arrow from right, arrow from left, balloon`
`! + B`	`landmine, cage, bomb`
`/ \`	`deflectors`
`T A X @`	`teleport, arrival, exit, start`
`M S C ~`	`big monster, baby monster, time capsule, thingy`

Due to its fixed width (40) and height (16), a Wanderer level is not always surrounded by walls; you might have to add them.

Note that Enigma does not yet support the game elements of Wanderer, hence this function currently is only of use to developers.

12.6 libsoko

This library is described as of release 1.

You can load it by adding a '`dependency`' element to the Section 3.3.6 [<compatibility>], page 33, XML Metadata element as follows:

```
<el:dependency el:path="lib/libsoko" el:id="lib/libsoko" el:release="1" el:preload="tru
```

It preloads automatically the libraries Section 12.5 [libimport], page 366, Section 12.4 [libmap], page 344, Section 12.3 [libmath], page 338, and Section 12.2 [liblua], page 335.

The only function which is meant to be used in levels is '`lib.soko.create_sokoball`'.

Syntax: **lib.soko.create_sokoball**(*multilevel*, *sublevel_number*, *args*)

multilevel A multilevel string in the sense of Section 12.5 [libimport], page 366.

sublevel_number
A number determining the number of the level in `multilevel`. Default is '`1`'.

args A table holding optional information to construct the level, default is {}. The following keywords are currently supported, all other keywords will return an error:

design A number or a design table, see below.

maxdesign A number, see below.

Syntax Samples:

```
lib.soko.create_sokoball(many_levels, 13, {design = 48})
lib.soko.create_sokoball(many_levels, 12, {maxdesign = MAXDESIGN[1.1]})
```

Details: '`create_sokoball`' creates a sokoball-level from the string `multilevel`. This string can be a multilevel, in which case '`sublevel_number`' determines the number of the level, starting with 1 (default is 1).

The design can be chosen by '`design`'. This is either a number, which refers to the list of predefined designs in `libsoko_designlist.xml`, or a table with the corresponding design entries. A missing entry will be interpreted as the entry from lib.soko_designlist.default. If the '`design`' variable is omitted, a check-number is created from the level which uniquely* determines a design from the design list, with `maxdesign` as highest possible design number.

*Uniquely means: The design might change when the design list is enlarged.

The number of available designs is 150 in Enigma 1.1, which equals the constant `MAXDESIGN[1.1]`. However, further versions of Enigma might support more designs. If a multilevel is loaded with a (numerically given) maxdesign number which is larger than the number of available designs, only those levels will be available for play whose calculated design number is supported, all others will show an error message. However, it is better to use the MAXDESIGN-constants. These will always raise an error, when the requested designs are not available. The MAXDESIGN-constants are read-only.

If both the design argument as well as the maxdesign-number are omitted, the original 150 designs will be used as fallback, no matter which version of Enigma is running.

To define own designs, please consult '`data/levels/lib/libsoko_designlist.xml`' or use Section 12.5 [libimport], page 366, in the first place.

Returns width and height of new Enigma level.

13 Advanced Features

13.1 Resolvers

Every tile in the world is defined by a key that needs to be resolved to its declaration. This can be done either by the Section 5.12 [Tiles Repository], page 107, '`ti`' alone, or by additionally chained resolvers. In the chapter Chapter 5 [Lua API], page 63, we learned how to set up a Section 5.13 [World], page 108, by static Section 5.11 [Tile and Object Declaration], page 106s. Now it is time to explore the capabilities of resolvers. In the Section 5.13.1 [World Creation], page 108, you had to supply a top resolver as an argument. Let us look which types of resolvers are available and how you can chain these resolvers.

13.1.1 Resolver Chaining

There exist several useful resolvers that may simplify the task of level writing or provide dynamic features like randomness, mazes, etc. Each of them handles just some keys out of your world map. For the other keys the resolver has no idea how to resolve them to object declarations. Thus each resolver has to be linked to a so called '`subresolver`'. The resolver just forwards all key requests that it can not handle itself to its subresolver. Indeed it will in most cases even forward modified key requests to its subresolver that are required by the process of handling its own keys.

The last resolver in the chain will either use the Section 5.12 [Tiles Repository], page 107, '`ti`' as its subresolver or a Section 13.1.2 [Custom Resolver], page 373, function, which will be '`ti`' based, too.

A typical resolver chain will look like:

Syntax Sample:

```
subresolver = res.random(ti, ...)
topresolver = res.composer(subresolver)
width, height = wo(topresolver, ...)
```

Details: The call of every resolver returns a context reference handle, that must be supplied to the upward resolver in the chain. Thus you need to start with the lowest resolver in your level code. The Section 5.13.1 [World Creation], page 108, takes the top most resolver context handle.

There is no limit to the number of chained resolvers. But the order of resolvers may sometimes be critical. Please read carefully the resolver notes for usage, restrictions and caveats.

Full Example:

The level "Demo Resolver Chain" of levelpack "Demolevels":

```
ti["~"] = {"fl_water"}
ti["s"] = {"fl_sahara"}
ti["t"] = {"fl_tigris"}
ti["1"] = {"ac-blackball", 0, 0.5}

ti["template_trigger"] = {"it_trigger", target="myoxyd%%", action="open"}
ti["template_oxyd"]    = ti["~"] .. {"st_oxyd", "myoxyd%%"}
```

```
myrandom = res.random(ti, " ", {"s", "t"})

myautotile = res.autotile(myrandom, {"a", "h", "template_trigger"},
                              {"A", "H", "template_oxyd"})

w, h = wo(myautotile, " ", {
"A~                ~E",
"~~                ~~",
"~~   h        b   ~~",
"~~                ~~",
"B~     c    d     ~F",
"~~                ~~",
"~~        1       ~~",
"~~                ~~",
"C~     f    e     ~G",
"~~                ~~",
"~~   g        a   ~~",
"~~                ~~",
"D~                ~H"
})

wo:shuffleOxyd()
```

13.1.2 Custom Resolver

A custom resolver is a function in the level that allows a dynamic remapping of tiles. When this function is registered in the resolver chain it is called once for every tile to be set. The tile that this function returns will be set.

Typical use cases are design patterns that are easy to calculate, but tedious to draw in the map and dynamic generated levels that differ slightly on every restart.

Syntax: tile = **myresolver**(*key*, *x*, *y*)

key String that contains the tile key to be resolved.

x The world x coordinate of the tile.

y The world y coordinate of the tile.

Details: A custom resolver function is the last resolver that is called in the chain. It has to return the final tile that should be drawn at the given position. This can be done by statement '`return ti["k"]`', which references the tile already declared in the tile map.

If no suitable tile was declared you can alternatively return a new tile like '`return ti({"st_switch", state=ON})`'.

If you decide not to draw any tile at all, you must return an empty tile declaration: '`return {"nil"}`' or '`return {}`'.

'`return nil`' indicates an error of usage of an unknown tile key.

Example: The level "Demo User Resolver" of levelpack "Demolevels":

```
ti["r"] = {"fl_rough_red"}
ti["b"] = {"fl_rough_blue"}
ti["1"] = {"#ac-blackball"}

ti["x"] = {"it_cross"}

function myresolver(key, x, y)
    if key == " " then
        local center = ((x%3) * (y%3))%2
        local checker = ((math.modf(x/3) %2) + (math.modf(y/3) %2))%2
        if center + checker == 1 then
            return ti["r"]
        else
            return ti["b"]
        end
    else
        return ti[key]
    end
end

w, h = wo(myresolver, " ", {
"                    ",
"                    ",
"                    ",
"      x x           ",
"       x            ",
"      x x           ",
"                    ",
"          1         ",
"                    ",
"                    ",
"                    ",
"                    ",
"                    "
})
```

13.1.3 res.autotile

Autotiling reduces the number of required tile declarations by generating them according to given simple rules. The most common application are a bunch of identical switch like objects that all target the same type of object like a door or a laser. As each of them has its individual target object it would require to write a separate tile declaration with a unique tile key, e.g.

```
ti["A"] = {"st_floppy", target="laserA"}
ti["B"] = {"st_floppy", target="laserB"}
ti["C"] = {"st_floppy", target="laserC"}
```

```
ti["a"] = {"st_laser", name="laserA"}
ti["b"] = {"st_laser", name="laserB"}
ti["c"] = {"st_laser", name="laserC"}
```

Autotiling requires just one template tile of each type and substitutes any pattern '`%%`' by a unique substitution.

```
ti["template_switch"] = {"st_floppy", target="laser%%"}
ti["template_laser"]  = {"st_laser", name="laser%%"}
```

Independent on the number of required unique objects you have just one template. You just declare the used range of tile keys by a rule and are free to use them within your level map.

Syntax:

res.autotile(*subresolver*, *rules*)

subresolver
: Resolver to which unresolved requests should be forwarded. May be '`ti`' as the final resolver of the resolver chain.

rules = *rule*, *rule*,...
: One rule or as many as you like, all separated by a comma.

rule = *prefixrule* `|` *rangerule*
: Each rule can be either a prefixrule or a rangerule in any mixture

prefixrule = {*prefix*, *template*}
: A table with two entries. First a prefix string that is common to all tile keys that should be handled followed by key string of the template tile.

rangerule = {*first*, *last*, *template* [, *offset*]}
: A table with at least three entries. A string with the first key to be handled, followed by a string with the last key to be handled. The third value is the key string of the template tile. An optional fourth value, that defaults to `1`, defines the number of the first key on '`%%`' pattern substitutions.

Syntax Samples:

```
res.autotile(ti, {"A", "template_switch"}, {"L", "template_laser})
res.autotile(ti, {"a", "e", "template_trigger}, {"A", "E", "template_door"}
```

Details: Prefix rules need a key length of at least 2. You can not use it with maps of just one character per tile. The resolver will create a tile declaration for any tile key in the map that matches the given prefix. A copy of the template will be taken.

Within this copy of the template all occurrences of the two characters '`%%`' in explicit object declarations will be substituted by a single percent sign followed by the suffix of the used tile key. Thus a key of '`AD`' will target the laser '`laser%D`'. You need to use the key '`LD`' in the map for the matching laser.

Rangerules match any tile key in the given range. It can well be used in one character key maps. But it can be used in multicharacter maps, too. In this case the given first and last keys may just differ in the last character. Again a copy of the template rule will be generated and the '`%%`' patterns will be substituted. But in this case the substitution is composed of a single percent sign followed by an integer number, that counts the key position within the given range, starting with the given offset or default `1`. Thus a key of '`c`' in the syntax sample above will target the door '`door%3`'. You would need to use the key '`C`' in the map for the matching door.

The template tile definitions can well be composed of several concatenated tiles even with references of base tiles. The pattern substitution takes place on any attribute value containing string descriptions. A valid template would be:

```
ti["template"] = ti["~"] .. ti({"it_trigger", target={"door%%#*","laser%%"}}
```

A pattern substitution can even take place on a key of a referenced base tile. Every occurrence of the two characters '`%%`' in the key will be substituted by the suffix of the used tile key without a preceeding percent sign. E.g. the template:

```
ti["template"] = ti["P%%"] .. {"st_floppy", target="laser%%"}
```

applied to a key with the suffix '`d`' will result in a base tile key '`Pd`'. This feature is especially useful if the autotile resolver is chained to another subresolver which generates the base tiles.

Full Example:

```
ti[" "] = {"fl_sahara"}

ti["template_a"] = {"st_floppy", target={"door%%#*","laser%%"}}
ti["template_A"] = {"st_blocker", "door%%#"}
ti["template_1"] = {"st_laser_s", "laser%%"}

ti["x"] = {"#ac-marble_black"} .. ti({"it_floppy"})

local resolver = res.autotile(ti, {"a", "e", "template_a"},
    {"A", "E", "template_A"},  {"1", "5", "template_1"})

w, h = wo(resolver, " ", {
"                    ",
"                    ",
"   a   DB  e    BC  ",
"                    ",
"   CD  b   AE   c   ",
"                    ",
"   d   EA           ",
"                    ",
"           x        ",
"                    ",
"                    ",
"   4  2  5  1  3    ",
"                    "
})
```

A more elaborate example can be found in Section 13.3.2 [Orthogonal Autotiling], page 397.

Caveats: Do not use the hash sign '`#`' as suffix character for key length 2 and above autotiled keys. A key `"A#"` could result in an unexpected '`%%`' substitution in the name attribute. A name `"sample%%"` would be substituted by `"sample%#"` which is a name that will be autonumbered (see Section 4.2.3 [Object Naming], page 50).

13.1.4 res.composer

The composer resolver reduces the number of required tile declarations by generating them by composition of base tiles. Even small levels and nearly every large level will use many different objects in numerous tile compositions. As the usable one character tile key candidates will not suffice you will need to use two or three character tile keys. But you will need numerous tile declarations, one for every used object combination.

The composer frees you from declaring every used combination. You just declare the base objects, e.g. the floors and all stones, items, actors and use combinations of these base tiles keys. The composer constructs the required tile declarations on the fly. E.g. with the following base tile declarations:

```
ti[" ."] = {"fl_space"}
ti[" ~"] = {"fl_water"}
ti["X "] = {"st_grate"}
ti["h "] = {"it_hammer"}
```

You can freely use any of the additional combinations like `"X."` - a grate on space, `"X~"` - a grate on water, `"h."` - a hammer on space, `"h~"` - a hammer on water.

Syntax:

res.composer(*subresolver*)

res.composer(*subresolver*, *sequence*)

subresolver
Resolver to which unresolved requests should be forwarded. May be '`ti`' as the final resolver of the resolver chain.

sequence Search sequence for basic tile declarations given as a string of priority numbers. The sequence defaults to `"123456789"`.

Syntax Samples:

```
res.composer(ti)
```

Details: For every key in the map the subresolver will be first requested for a tile declaration. Thus any given explicit declaration will precede the auto composition.

Just in case that no declaration exists the search starts for existing subkey tiles. Subkeys are keys with all but some characters replaced by a whitespace '` `'.

The search sequence is given by the optional second argument and defaults to `"123456789"`. In the first step all character positions marked by a '`1`' in the sequence string are maintained in the key string and all others are replaced by whitespace. In the second step all character positions marked by a '`2`' in the sequence string are maintained in the key string and all others are replaced by whitespace. This procedure continues until the number equals the key length. All generated subkeys are resolved by the subresolver and concatenated in the given sequence.

With the default sequence "123456789" a key request for "~mX" is resolved to subkeys "~ ", " m " and " X". These subkeys are resolved by the subresolver. If the subresolver is 'ti' the result is:

```
ti["~  "] .. ti[" m "] .. ti["  X"]
```

With a key length of 3 or more characters it is sometimes useful to avoid a total decomposition into single character based subkeys. E.g. you may want to use a Section 13.1.3 [res.autotile], page 374, or Section 13.1.6 [res.puzzle], page 382, as subresolver. Both have the need of essential 2 character subkeys. In this case you can simply define the sequence as "122" for a key length of 3. A key request of "~Pa" will be resolved to subkeys "~ ", " Pa". In case of a puzzle subresolver this would result in:

```
ti["~  "] .. ti[" P"]
```

with second tile declaration being a Section 9.5.52 [st_puzzle], page 292, declaration with the 'connections' attribute being set to "w" according to the last key character 'a'.

With a "231" you stick to a total decomposition, but you redefine the sequence of evaluation and composition. For the key "~mX" you would get in contrast to the first example:

```
ti["  X"] .. ti["~  "] .. ti[" m "]
```

In all cases, subkeys, that are strings of whitespace only, will simply be ignored. With the default sequence the key "~ X" will result just in:

```
ti["~  "] .. ti["  X"]
```

If you set your floors by usage of the composer you should use the all whitespace key as your default floor as this key does not resolve via the composer and needs the backup of the default mechanism.

Full Example:

```
ti["  "] = {"fl_sahara"}
ti[" ="] = {"fl_tigris"}
ti[" ."] = {"fl_abyss"}
ti[" ~"] = {"fl_water"}
ti[" ;"] = {"fl_lawn"}

ti["# "] = {"st_granite"}
ti["W "] = {"st_wood"}
ti["X "] = {"st_oxyd"}
ti["G "] = {"st_grate_cross"}

ti["2 "] = {"it_coin_s"}
ti["s "] = {"it_seed"}
ti["c "] = {"it_cherry"}
```

```
ti["h "] = {"it_hammer"}

ti["k "] = {"it_key"} .. ti({"st_lightglass"})

ti["xx"] = {"#ac_marble_black"}

local resolver = res.composer(ti)

w, h = wo(resolver, "  ", {
--0001020304050607080910111213141516171819
 "                                        ",
 "  h= ;W;2;c G~ ~# #.2.X X~k=k;          ",
 "                                        ",
 "  2;s;    2.s.    2=s=                  ",
 "  c;h;    c.h.    c=h=    xx            ",
 "                                        "
})
```

13.1.5 res.maze

The maze resolver supports you in the creation of quite arbitrary mazes. The shape is no longer limited to boring rectangular areas of one grid thick walls leaving the player just a one grid path uniquely connecting all parts of the maze.

This second generation maze generator lets you fill mazes in arbitrarily shaped areas, mazes with thick walls or chasms, or thin walls of just a sheet of window glass, mazes with cells of single grid, cells that are whole islands or mazes based on Section 8.4.16 [it_strip], page 224, that have cells of no extent and consist of connections only. The maze cells may be aligned strictly rectangular or shifted in one direction, they may be just connected to its 4 neighbors or to 6 neighbors in hexagonal mazes or three dimensional mazes. You can write and plug in your own maze generation and rendering algorithms. And finally you can analyse, postprocess and even modify your maze even after the initial creation.

From the mathematical point of view we provide the basic structures for generation of quite arbitrary directed graphs. Our maze consists of cells, the vertices of a graph. Every cell can be connected to a given number of neighbor cells. But these connections, that are the passages from one cell to another, can even be direction dependent. This allows you to use window panes on either side of a connection or to use oneways for your connections, too. These passages from one cell to another are the edges of our graph and as they may be directed we have a directed graph. But for most mazes the support of directions is irrelevant and transparent, and you do not really need to know anything about graphs at all. Thus we called the resolver just a maze resolver.

Of course such a versatile resolver needs some configuration. As the parameters exceed the number of arguments, that you can reasonably supply to a function just by enlisting them, we decided to group the parameters for specific tasks and to use a table with named attributes for the configuration. This sounds more complex than it is. But watch out carefully for the table curly braces as they are necessary and can not be omitted.

In a big level you may want to generate two or even more completely independent mazes. You can do this by using multiple instances of this resolver. The resolver handle returned on the configuration is a unique reference pointer for the maze for subsequent requests. Store it and link all the maze resolvers as explained in Section 13.1.1 [Resolver Chaining], page 372.

Location: This resolver is part of the library '`libmaze`' as of release 2. You can use it by adding the following dependency to your level Section 3.3.6 [<compatibility>], page 33, declaration:

```
<el:dependency el:path="lib/libmaze" el:id="lib/libmaze" el:release="2" el:p
```

The library Section 12.4 [libmap], page 344, is automatically preloaded by this resolver.

Syntax:

themaze = **res.maze**(*subresolver*, *attributes*)

subresolver
: Resolver to which unresolved requests should be forwarded. May be '`ti`' as the final resolver of the resolver chain.

attributes = {*keyvalue*, *keyvalue*,...}
: An anonymous table with one or many attributes given as key value pairs, separated by a comma.

keyvalue = <area=*area_value* | render = *render_value* | kernel = *kernel_value* | spacing = *spacing_value* | persistent=*persistence*>
: Values for given keys that may occur in any sequence in the anonymous table.

area_value = {<*rectangular_area* | *marked_area*>}
: The maze area specification, that is either defined as a rectangular area or an area marked in the world's map.

rectangular_area = *anchor*, *width*, *height*
: An rectangular area that is given by an anchor position within the world and two numbers for the width and height measured in maze cells.

anchor Anything that is convertible to a Section 5.5 [Position], page 89, that denotes the upper left edge of the rectangular maze area. Besides a position value, an object reference or a name string of an object or position are supported value types.

marked_area
: One or multiple strings separated by a comma as simple entries in the anonymous table. Every string does either specify a key match, a key prefix or an object name. All these strings can be used at the same time for marking an area. The strings can occur in any sequence and multiplicity.

kernel_value = {kernel_width, kernel_height}
: The size of the kernel of a cell given by width and height in number of grids.

spacing_value = {spacing_x, spacing_y}
: The distance of the kernel of one cell to its neighbor in x and y direction measured in number of grids.

render_value = {<*std_renderer_args* | *other_renderer*>}
: The specification for drawing the maze. In case of a missing specification no drawing will be done at all. If the default standard renderer should be used its parameters can be directly supplied, other renderers need a type specification plus the necessary configuration information.

std_renderer_args = *passage_keys* [, <*wall_key* [, *kernel_key*] | *cell_map*>]]
: The standard renderer takes info about tile keys to be used for the passages, and either a cell map, or additional tile keys for the wall and optionally the kernel of a cell.

passage_keys = <*passage_key* | {*passage_open*, *passage_closed*}>
: Usually you just give a tile key for open maze passages. Closed passages appear like walls and use the same tile key. But in case you want to use special tile keys for open and for closed passages you can supply two strings in an anonymous table. If you give no wall key you may need to include an '`st_nil`' in your open passage tile declaration to kill a wall stone drawn by your world map.

wall_key
: The tile key to be used for drawing walls. If it is omitted no wall is drawn and the resolver relies on all possible wall tiles to be drawn by the world map itself.

kernel_key
: In most cases the cell kernel will be drawn by the world map. But if not you can supply a tile key that will be drawn on every cell kernel grid.

cell_map
: Instead of kernel and wall tile keys you can supply a Section 12.4 [libmap], page 344, map of a complete cell. The map can provide arbitrary tiles for cell kernels larger than a single grid. The walls can differ on the south and east side, too.

other_renderer = *renderer* [, *other_renderer_args*]
: Enlisting of a renderer function followed by its specific arguments.

renderer
: The function that does the rendering. By default it is '`lib.maze.renderer_standard`' with the above given arguments. Other supplied renderers are '`lib.maze.renderer_window`' and '`lib.maze.renderer_strip`'

persistence
: A boolean flag that defaults to '`false`'. You need to set it to '`true`' if you want to access the maze or any of its cells after the level initialization. Otherwise the maze reference handle with all its data may get invalid due to memory garbage collection. This is no problem for most mazes, that will be directly rendered and have no need of further evaluation or changes during runtime.

Syntax Samples:

```
maze1 = res.maze(ti, {area ={"anchor1", 4, 5}, render = {" ", "-", " "}})
maze2 = res.maze(ti, {area ={"."}, kernel={1,1}, render = {"!", "~", "-"}})
maze3 = res.maze(ti, {area ={"amaze#*"}, render = {{".","+"}, "~", "-"}})
maze4 = res.maze(ti, {area ={po(2, 12), 5, 5}, kernel={3,2},
                    render = {".", wo:newMap(" ", {"!!!~","--!~","~~~~"})}})
```

Details: To be written.

Full Example:

13.1.6 res.puzzle

The puzzle resolver helps you to reduce the number of required tile declarations for clusters of Section 9.5.52 [st_puzzle], page 292, stones. By usage of the '`cluster`' attribute of Section 9.5.52 [st_puzzle], page 292, you can easily set clusters of fully connected stones. But for irregular, internally just partial connected puzzles you often need a bunch of similar tile declarations that differ just in the '`connections`' attribute value.

```
ti["B1"] = {"st_puzzle_blue", cluster=1}
ti["Ba"] = {"st_puzzle_blue", connections="w"}
ti["Bb"] = {"st_puzzle_blue", connections="sw"}
ti["Bd"] = {"st_puzzle_blue", connections="ew"}
ti["Bh"] = {"st_puzzle_blue", connections="n"}
```

Like Section 13.1.3 [res.autotile], page 374, this resolver offers autotiling. You just define one template tile and can use all connections variations

```
ti["B"] = {"st_puzzle_blue"}
```

Additionally this resolver registers every puzzle stone set and allows you to shuffle the puzzle clusters. You can even select shuffle algorithms and define accessible sides of a puzzle.

Location: This resolver is part of the library '`libpuzzle`' as of release 3. You can use it by adding the following dependency to your level Section 3.3.6 [<compatibility>], page 33, declaration:

<*el*:**dependency** *el*:**path**="*lib/libpuzzle*" *el*:**id**="*lib/libpuzzle*" *el*:**release**="*3*"

Syntax:

res.puzzle(*subresolver*, *rules*)

subresolver
: Resolver to which unresolved requests should be forwarded. May be '`ti`' as the final resolver of the resolver chain.

rules = *rule*, *rule*,...
: One rule or as many as you like, all separated by a comma.

rule
: The string of the template tile key that is the common tile key prefix for all autogenerated tile declarations.

Syntax Samples:

```
res.puzzle(ti, "B", "Y", "I", "M")
```

Details: The puzzle resolver assumes a tile key length of two or more characters. The given rules are prefix strings which need concat with a one character suffix to a standard tile key. Given a rule with a proper template rule you can use any of the following suffices without tile declaration:

Suffix		Cluster	Connections
Solid	Hollow		
'0'	'5'	0	autoconnect
'1'	'6'	1	autoconnect
'2'	'7'	2	autoconnect
'3'	'8'	3	autoconnect
'4'	'9'	4	autoconnect
' '	'+'	nil	""
'a'	'A'	nil	"w"
'b'	'B'	nil	"s"
'c'	'C'	nil	"sw"
'd'	'D'	nil	"e"
'e'	'E'	nil	"ew"
'f'	'F'	nil	"es"
'g'	'G'	nil	"esw"
'h'	'H'	nil	"n"
'i'	'I'	nil	"nw"
'j'	'J'	nil	"ns"
'k'	'K'	nil	"nsw"
'l'	'L'	nil	"ne"
'm'	'M'	nil	"new"
'n'	'N'	nil	"nes"
'o'	'O'	nil	"nesw"
'p'	'P'	10	autoconnect
'q'	'Q'	11	autoconnect
'r'	'R'	12	autoconnect
's'	'S'	13	autoconnect
't'	'T'	14	autoconnect
'u'	'U'	15	autoconnect
'v'	'V'	16	autoconnect
'w'	'W'	17	autoconnect
'x'	'X'	18	autoconnect
'y'	'Y'	19	autoconnect
'z'	'Z'	20	autoconnect

All puzzle stones set by this resolver will be registered and shuffled by default with the '`intensity`' of 3. You can define other intensity attribute values on any puzzle stone. The maximum intensity of all stones in a cluster will be taken. The intensity multiplied by the number of stones in a cluster describes the number of inverse pushes, called pulls, that will be performed during shuffling. Thus an intensity of 3 on a cluster of 6 stones will perform 18 pulls. That means it is guaranteed that you can solve the puzzle with 18 pushes. But as some pull operations may neutralize the user may be able to solve such a shuffled puzzle with less than 18 pushes.

If you define no shuffle '`algorithm`' it is assumed that the user can rotate the puzzle from any side and any Section 9.5.52 [st_puzzle], page 292. The requested number of shuffling pull operations will be performed from random puzzle stones in a manner that guarantees that the user can solve the puzzle if he has free access to all sides.

If you set the '`algorithm`' on any of the puzzle stones to the value `"marked"` the resolver registers that the user has no free access, but just from positions that you did mark. You do mark a position by setting the attribute Section 7.2.16 [push_directions], page 152, on a floor. All floors adjacent to puzzle stones, including floors beneath another puzzle stone, will be checked for this attribute. It is your responsibility to mark all floors and to ensure that the player has continuous access to these floors for solving the puzzle by push rotations. The attribute takes a string value, a substring of `"nesw"`. If it contains the character of the required push direction this push event will take part in the random reverse shuffling process.

Note that hollow stones and their restriction of not being able to initiate a rotation if fully respected on shuffling.

Full Example:

```
ti["  "] = {"fl_sahara"}
ti["##"] = {"st_granite"}

ti[".."] = {"fl_sahara", push_directions="nesw"}

ti["B"] = {"st_puzzle_blue"}
ti["Y"] = {"st_puzzle_yellow"}
ti["I"] = {"st_puzzle_blue", intensity=2/6}
ti["M"] = {"st_puzzle_blue", algorithm="marked", intensity=10}

ti["xx"] = {"#ac_marble_black"} ..ti({"it_magicwand"})

local resolver = res.puzzle(ti, "B", "Y", "I", "M")

w, h = wo(resolver, "  ", {
"                                        ",
"B1B1B1B1                                ",
"B2B1BjB1                      Y1Y6Y1    ",
"B2B2B2B2                      Y1Y1YC    ",
"                                Y6YnY1  ",
"                ##########      Y1Y1Y1  ",
"                ##M1M1M1##              ",
"  I1I1          ##M1McM1..              ",
"  I6Ia          ..M1M1M1..      xx      ",
"  I1I1            ....####              ",
"                                        ",
"                                        ",
"                                        "
})
```

13.1.7 res.random

With map based level description you have explicit control about the objects being set on every single grid. But sometimes you may want to introduce some randomness in the used objects. E.g. a floor may be made up of two types at random to generate a different look on every level start. The randomness would even make a level more difficult to play if one of the two floors would invert the mouse forces. The random resolver allows you to set up such cases.

Syntax:

res.random(*subresolver*, *hits*, *replacements*)

subresolver
: Resolver to which unresolved requests should be forwarded. May be '`ti`' as the final resolver of the resolver chain.

hits = *key* | {*hit*, *hit*, ...}
: Either a single tile key string that defines the tiles to be randomized, or a table of hit descriptors that should all be examined in parallel.

hit = *key* | {*key*, *superkey*}
: Either a single tile key string or a pair of tile key string and a related tile superkey string. The superkey tile will be set additionally to the random replacement.

replacements = *key* | {*replacement*, *replacement*, ...}
: Either a single tile key string that would be taken without randomness or as in most cases a table of replacement descriptors from which the resulting tile should be selected with randomness.

replacement = *key* | {*key*, *frequency*}
: Either a single tile key string that should be taken with a frequency of '`1`', or a pair of a tile key string with a given frequency number. The frequency can be an integer or non-integer number, but must be positive or zero.

Syntax Samples:

```
res.random(ti, "x", {"a", "b"})
res.random(ti, {{"x", "y"},{"i","j"}}, {{"a", 2}, {"b", 1}})
```

Details: Every key in the map is checked against the given hit key strings. If it fits one of them a replacement will take place.

The replacement will be one of the replacement tile keys resolved via the subresolver. The different keys will be chosen with a likelihood according to the ratio of the given frequency numbers. If no frequency is supplied a default of '`1`' is taken. Thus in the first example both keys are taken in a ratio 1:1, whereas in the second the ratio will be 2:1.

When a superkey is given for a hit key this superkey will additionally be resolved via the subresolver. This feature allows to use randomness on tiles with more than one object on a grid position. E.g. an item or an actor on a random floor.

The other objects can be set via the superkey while the random floor is set according to the replacement rules.

Full Example:

```
ti["~"] = {"fl_water"}
ti["s"] = {"fl_sahara"}
ti["t"] = {"fl_tigris"}
ti["i"] = {"fl_inverse_gray"}
ti["b"] = {"fl_yinyang_yin"}
ti["w"] = {"fl_yinyang_yang"}

ti["c"] = {"it_coin_s"}
ti["p"] = {"it_brush"}

ti["1"] = {"ac_marble_black", 0, 0.5}

simple_random = res.random(ti, " ", {"s", "t"})

full_random = res.random(simple_random, {".",{"C","c"},{"p","p"}},
                                        {{"i",3},{"b",4},{"w",1}})

w, h = wo(full_random, "s", {
"         ~~.........",
"         ~~.........",
"         ~~......C..",
"         ~~.........",
"         ~~.........",
"         ~~.........",
"         c1.........",
"         ~~.........",
"         ~~.........",
"         ~~.........",
"         ~~......p..",
"         ~~.........",
"         ~~........."
})
```

Note that in this example we can use ‘`p`’ as key as well as superkey. This is due to the fact that nowhere else this tile is directly set. Whereas the tile key ‘`c`’ is used for another tile with the default floor. Thus we do need to use another unique key ‘`C`’ for the coin on our random floor.

13.1.8 res.train

The train resolver supports you in the set up of train like wandering floor chains. Usually short passages of solid standard floors wander on a closed path of otherwise unpassable floors like Section 7.4.1 [fl_abyss], page 166, or Section 7.4.13 [fl_water], page 178.

The path itself is called railway, even though the name train does not really fit the features of the wandering floor chains. But these names have been chosen by Petr Machata in his first implementation of a simple wandering floor feature.

In contrast to real world train, the wandering floors themselves do not move at all. Thus they do neither carry items or stones, nor do they allow an actor to rest on them and to be automatically transported along the path. The train is more like a curb wheel of a trunk. New floors are added to the front while trailing floors are removed.

Actually a chain of floors is composed of two train locos which move along the railway path. One at the front that sets floor of the standard passable kind and one at the end, or exactly one grid behind the end, that resets floor of the unpassable floor kind.

Usually both train locos move at the same speed keeping the passable floor chain length constant. But this resolver allows you to set up arbitrary number of train locos moving in arbitrary direction at arbitrary speed on a railway. But the resulting floor patterns will likely no longer behave like trains. Nevertheless we keep the name.

Every railway path has to be described by a chained train resolver instance. The paths of different resolvers may cross each other, but crossing trains may cause unexpected results as the train locos just set floors without any respect to other trains. In future it is planned to add track and train line attributes, which will allow even more complex railways.

Syntax:

res.train(*subresolver*[, *suffix*][, *hits*])

subresolver
: Resolver to which unresolved requests should be forwarded. May be '`ti`' as the final resolver of the resolver chain.

suffix
: An optional key suffix string. Every grid position with a matching key is registered as part of the railway path.

hits = *hit*, *hit*, ...
: One or many resolver key hits that will identify positions of the railway path with optional trains located on them.

hit = *key* | {*key* [, *subkey*][, edge=*edgevalue*][, train=*trainvalue*]}
: Either a single tile key string or a table of a tile key string with an optional related tile subkey string and optional further arguments.

edgevalue
: A railway position that marks one of two edges spanning a rectangular railway path.

trainvalue = {*successorkey* [, *predecessorkey*] [, length=*trainlength*] [, orientation=*traveldirection*] [, interval=*speed*] [, name=*namevalue*]}
: A train loco that moves with the given speed interval, defaulting to 0.25 seconds per grid, and starting into the given travel direction. The loco sets floors given by the successor key string that will be resolved via the subresolver. If a trainlength is given, a second train loco is automatically created that preceeds this one by the given length. This front train loco will set floors defined by the predecessor key string. If the train loco has an assigned name string, the front train loco will be named with an appended `"_front"`.

Syntax Samples:

```
res.train(ti, ".", {" ^", train={" ~", " w", orientation=NORTH, length=6, in
res.train(ti, {"e", edge=true}, {">", train={" w", orientation=EAST}}, {"<",
```

Details: Every key in the map is checked against the given hit key strings. If it fits one of them the positition is added to the railway path and the subkey is used to set remaining objects via the subresolver onto the grid. If no subkey is given no additional objects are set.

If the key is no hit, but a suffix string is given and matches the key, the position will be registered as part of the railway path, too. In this case the suffix part of the key will be replaced by space characters and the resulting key will be resolved via the subresolver.

There is no need of marking every grid position of a railway, what would be a very annoying task if many stones and items are positioned on its path. By default every train moves straight forward. You just need to provide hints for positions where the train turns left or right. Marking the positions of the path that follow every turn is sufficient.

Full Example:

```
ti["  "] = {"fl_sahara"}
ti[" ~"] = {"fl_water"}
ti[" w"] = {"fl_wood"}
ti["# "] = {"st_rawglass"}
ti[" @"] = {"#ac_marble"}

railway1 = res.train(ti, ".", {"1^", train={" ~", " w", orientation=NORTH, l
railway2 = res.train(railway1, {"2e", edge=true}, {"2^", train={" ~", " w",

wo(railway2, "  ", {
    "             .        ",
    "   .                  ",
    "              1^      ",
    "                     @",
    "              #       ",
    "          2e          ",
    "                      ",
    "                      ",
    "  # #.            2^  ",
    "       .              ",
    "                  2e  ",
    "               .      ",
    "         .            "
})
```

The first railway has just marked the essential positions that define the path.

13.2 General Features

13.2.1 Display Follow Strategy

As the world can be larger than a display screen the active marble can move out of the area that is visible at level start. Somehow the display has to follow the active marble.

Whereas prior Enigma versions did provide just a handful of fixed modes, future versions will give you a much more detailed control of the display following strategy. We decided to switch the configuration to the future parameters already now. This allows us to give you some more follower control, even though some attributes are still limited in their values.

The strategy is described by the following parameters.

Attributes:

Section 6.4.12 [FollowGrid], page 141
Section 6.4.13 [FollowMethod], page 141
Section 6.4.14 [FollowThreshold], page 141
Section 6.4.11 [FollowAction], page 140

Syntax Samples:

```
wo["FollowGrid"] = true
wo["FollowMethod"] = FOLLOW_SCROLL
```

Details: The attributes should always be set in the sequence as given above. This is due to the fact that the first attributes may reset some of the later attributes to matching defaults. This way you will have to set just a two attributes for the most common cases.

You can set the display follow strategy at any point. You are even allowed to switch the strategy during the running game.

Valid Configurations as of Enigma 1.10:

Screen Flipping:

```
wo["FollowGrid"] = true
wo["FollowMethod"] = FOLLOW_FLIP
```

The default strategy. The screen flips as soon as the marble reaches the outer half of the boundary grid tile. The screen moves by a full screen minus the common tile row or column.

Half Screen Scrolling:

```
wo["FollowGrid"] = true
wo["FollowMethod"] = FOLLOW_SCROLL
wo["FollowAction"] = FOLLOW_HALFSCREEN
```

As soon as the marble reaches the outer half of the boundary grid tile the display scrolls pixel by pixel by half a screen. It realigns to the grid. As on a standard sized screen the display would have to scroll 9.5 grids in horizontal direction such scrolls will alternate in scrolls of 9 and 10 grids. The follower will try to stabilize the reachable scroll positions.

Permanent Smooth Scrolling:

```
wo["FollowGrid"] = false
wo["FollowMethod"] = FOLLOW_SCROLL
```

The active actor will always stay in the center of the screen. The display compensates the actor's movement pixel by pixel by scrolling. The display positions are not aligned to grid tiles.

Full Screen Scrolling:

```
wo["FollowGrid"] = true
wo["FollowMethod"] = FOLLOW_SCROLL
wo["FollowAction"] = FOLLOW_FULLSCREEN
```

As soon as the marble reaches the outer half of the boundary grid tile the display scrolls pixel by pixel by a full screen minus the common tile row or column.

No Screen Scrolling:

```
wo["FollowMethod"] = FOLLOW_NO
```

No scrolling at all. Even if the active actor moves out of sight the display remains at its position.

Screen Flipping at a given threshold:

```
wo["FollowGrid"] = true
wo["FollowMethod"] = FOLLOW_FLIP
wo["FollowThreshold"] = po(2.5, 1.5)
```

The screen flips as soon as the marble reaches the given distance to the screen boundary. The screen moves by a full screen minus twice the threshold distance. The final display realigns to the grid even on odd threshold distances.

Full Screen Scrolling at a given threshold:

```
wo["FollowGrid"] = true
wo["FollowMethod"] = FOLLOW_SCROLL
wo["FollowThreshold"] = po(2.5, 1.5)
```

The screen scrolls as soon as the marble reaches the given distance to the screen boundary. The screen moves by a full screen minus twice the threshold distance. The final display realigns to the grid even on odd threshold distances.

13.2.2 Flood Spreading

A flood is active Section 7.4.13 [fl_water], page 178, that, originating from a source, spreads over Section 7.2.6 [floodable], page 150, areas. In contrast to a flood standard water is just static, its '`state`' is '`IDLE`' and it will not spread to adjacent floors. But a flood reaching a static water lake will cross it as a tsunami and continue actively spreading on all riparian zones.

You set up the area by adding the attribute Section 7.2.6 [floodable], page 150, with value `true` on all its floors. Just Section 7.4.13 [fl_water], page 178, and the framed variants of Section 7.4.14 [fl_wood], page 179, Section 7.4.5 [fl_hay], page 171, and Section 7.4.8 [fl_rock], page 173, do not require to be explicitly marked floodable as they are floodable by default. The marked area is the maximum area that may be flooded. But obstacles may block the flood temporarily or permanently.

A flood starts at a source. As soon as you add a 'fl_water_source' or set the 'state' to 'FLOODING', the Section 7.4.13 [fl_water], page 178, starts to spread to floodable neighboring grids with a speed defined by the attribute 'interval'. The speed will be inherited to floors flooded by the stream.

Floodable floors with solid stones, closed doors or Section 9.5.70 [st_window], page 313, with blocking faces on top will keep the flood from spreading to their grid position or if already flooded to spread to a neighboring grid. But as soon as the obstacle vanishes, e.g. an Section 9.5.20 [st_door], page 258, opens, the flood continues to spread. Hollow stones, especially Section 9.5.43 [st_oneway], page 282, do not block flood streams, totally independent of actor blocking features on certain types or faces.

Of special interest are the Section 9.5.7 [st_box], page 248, variants and their successor floors, the framed variants of Section 7.4.14 [fl_wood], page 179, Section 7.4.5 [fl_hay], page 171, and Section 7.4.8 [fl_rock], page 173. A flood will flow beneath a box stone, if the floor beneath is floodable. In consequence of the upcoming water, the box stone will fall and build a framed floor of the given kind. These floors act like bridges over flooding water. They still let the flood spread to further neighboring floodable floors. Thus a user can not stop a flood by pushing an Section 9.5.7 [st_box], page 248, onto its path, but he can make the water passable for his marbles. In fact this framed floors can even operate as a flood source, but we do not recommend this usage.

In contrast to these floor building stones the Section 9.5.52 [st_puzzle], page 292, does neither fall on static nor on flooding Section 7.4.13 [fl_water], page 178. As a solid stone it will even block a flood on neighboring grids to reach its position. But of course once moved completely over Section 7.4.13 [fl_water], page 178, the puzzle will fall if its own conditions are met. The successor Section 7.3.14 [fl_gray], page 158, will not build a bridge over water. It fills up the ditch and replaces the water completely. Thus the user can use puzzles to stop a flood.

When a flood stream spreads to a new floor items on these floors may be affected. E.g. Section 8.4.4 [it_crack], page 213, get flooded and do vanish. All Section 8.4.3 [it_burnable], page 212, besides oil get wiped out, too.

Further active components of the flood concept are Section 8.4.19 [it_vortex], page 227, and Section 8.4.20 [it_wormhole], page 229. Besides actors both do spread a flood. The Section 8.4.20 [it_wormhole], page 229, spreads the flood to its 'destination' if the floor at this grid is marked 'floodable'. An Section 8.4.19 [it_vortex], page 227, will flood all its 'destination''s, but of course just if it is in state 'OPEN'. In case the destinations are vortices, too, they must be open, too, for a successful flood spreading. When the last closed vortex on either end opens again the hold flood continues to spread. Note that in these cases the flood reaches the destination grid from beneath. Thus no stone will block the emerging water. But nevertheless a stone on the destination position may well block the water from spreading to the neighboring grids.

Be aware that the Enigma flood has some extraordinary features. The most important is the ability to spread unlimitedly from every grid that got flooded, independently of a still existing connection to the flood source. Thus once a door is opened and a bit of the flood passes the door, the flood will continue to spread even if the door closes again. Same is true for toggling vortices or puzzle stones being pushed into a flood building a complete bridge over the water stream. But this feature is intentionally, as it avoids many shortcut situations and thus makes the flood more usable for level authors.

13.2.3 Fire Spreading

The 1.0-version of Enigma introduced a new fire system, making use of attributes and messages of the floor tiles. The default fire, once ignited, spreads over the landscape and destroys items, marbles and some stones. It spreads along those floor tiles that are marked "burnable" by default (like Section 7.4.5 [fl_hay], page 171, or Section 7.4.14 [fl_wood], page 179), by attribute (see attribute Section 7.2.2 [burnable], page 149), or by one of two items that indicate burnability: the invisible Section 8.4.3 [it_burnable], page 212, and the visible `it_burnable_oil`. On a burning floor, all items are destroyed. However, some items prevent the floor from burning, like Section 8.4.11 [it_meditation], page 219, or Section 8.3.11 [it_dynamite], page 192, (which ignites instead).

Fire can be ignited in several standard ways:

- The `setfire`-message sets fire to a floor if it is burnable and the item on it allows it to burn; non-burnable items like Section 8.3.11 [it_dynamite], page 192, are not ignited by this.
- The `heat`-message ignites burnable floors as does `setfire`, but also initiates a Section 13.2.4 [Heat-Transformation], page 394, of the floor and ignites items on it.
- The `ignite` and `explosion`-messages that are used by Section 8.3.11 [it_dynamite], page 192, and Section 8.4.2 [it_bomb], page 211, can initiate fire via Section 8.4.3 [it_burnable], page 212[_oil] or if the Section 7.2.12 [ignitable], page 151-attribute of the floor is set (off by default).
- The floor already starts burning on initialization when the `initfire`-attribute is set (off by default).
- Fire in the neighborhood, see below.

If needed, the `forcefire`-message can be used to set fire to non-burnable floors. Internally, it is equivalent to manually setting `it_burnable_ignited`; however, setting `it_burnable_ignited` manually is deprecated to allow a further development of the fire-system in future.

Fire does the following:

- It kills Section 9.5.7 [st_box], page 248_wood, Section 9.5.7 [st_box], page 248_hay, and Section 9.5.23 [st_flat], page 262_moveburnable above it, and Section 9.5.23 [st_flat], page 262_burnable beneath it.
- It melts Section 9.5.29 [st_ice], page 267, to Section 7.4.13 [fl_water], page 178.
- It heats its neighboring tiles, which might result in a Section 13.2.4 [Heat-Transformation], page 394, of the floor.
- It might ignite or destroy items on its neighbor, this concerns Section 8.3.11 [it_dynamite], page 192, both Section 8.4.2 [it_bomb], page 211, and Section 8.4.4 [it_crack], page 213.
- It might set fire to its neighbor.
- It shatters marbles that are not protected with Section 8.3.32 [it_umbrella], page 207, or other measures. Note that in future versions, jumping over fire with Section 8.3.29 [it_spring], page 205, might get allowed.

Fire stops burning after a random amount of time, as long as the `eternal`-attribute of the floor is not set. When it stops burning, it might replace the floor by another kind ("fire-transform"), this is: Section 7.4.14 [fl_wood], page 179, is replaced by Section 7.4.1 [fl_abyss], page 166, Section 7.3.17 [fl_lawn], page 159, by Section 7.3.12 [fl_dunes], page 157. Finally, it puts Section 8.4.3 [it_burnable], page 212_ash on the floor, which prohibits a second fire and which can be removed with Section 8.3.5 [it_brush], page 188. However, ash is not set if the Section 7.2.15 [noash], page 152-attribute is set (default only for Section 7.4.1 [fl_abyss], page 166).

Since the spreading of fire is a random event, in 0.92, a level author couldn't be sure that a particular item was ignited or fire was set. Since 1.0, these can be assured by setting the Section 7.2.17 [secure], page 152-attribute: When a burnable floor with `secure = true` is near fire, it will eventually catch fire, items on it are ignited, etc. `secure` is `false` by default.

In 0.92, there were two speeds of fire: When using Section 8.4.3 [it_burnable], page 212, fire spread much faster than without. This is still the same in 1.0 and above. However, you can set the Section 7.2.5 [fastfire], page 150-attribute to hasten the fire without setting the invisible Section 8.4.3 [it_burnable], page 212, this should be the preferred method.

Fire that burns under a stone is not allowed to spread; the only exceptions are floating stones like Section 9.5.27 [st_grate], page 266, and those stones that are destroyed by fire anyway (Section 9.5.7 [st_box], page 248_wood, Section 9.5.7 [st_box], page 248_hay, Section 9.5.23 [st_flat], page 262_burnable, Section 9.5.23 [st_flat], page 262_moveburnable). In contrast to this, fire might also spread to under a movable stone, but not further.

You can stop fire with `it_extinguisher`, which creates the fireproof `it_burnable_fireproof`. Another way to stop fire is to push the totally inert Section 9.5.7 [st_box], page 248_rock over it: This is the only movable stone that doesn't allow fire under it. A final way to stop fire is to send the `stopfire`-message to a floor.

Differences between 1.0 and 0.92

The old fire system of Enigma versions up to 0.92, differs from the 1.0 and above version mainly in the following points:

- no fire-transform except Section 7.4.14 [fl_wood], page 179, to Section 7.4.1 [fl_abyss], page 166,
- no Section 13.2.4 [Heat-Transformation], page 394s
- ash on Section 7.4.1 [fl_abyss], page 166,
- no difference between different floors
- replication via same-floor-pattern instead of burnable-floor-pattern: 0.92 didn't distinguish between burnable and non-burnable floors. Instead, fire was allowed to spread to floors of the same kind slowly.
- burnable items always catch fire: In 1.0 and above, a burnable item (except for Section 8.4.3 [it_burnable], page 212[_oil]) on a non-burnable floor won't catch fire, in 0.92 it did.

A good model of the 0.92-system can be attained via the compatibility-modes: All non-Enigma-modes (see Section 16.1 [Engine Compatibility], page 404, and Section 3.3.6 [<compatibility>], page 33) feature a version which only marginally differs from 0.92-fire, yet allowing some of the new achievements, like secure- or eternal-fire.

Note that in 0.92, fire-transformation happened at the beginning of the fire, which manifested in the so called "burning-abyss"-bug. Besides other details, this is how the original 0.92 system differs from the one in 1.0-non-Enigma-mode.

Burnable and Fireproof Floors

All floors that look like plastic, fabrics, or organics are burnable by default: `fl_adhesionless`, `fl_aquamarine`, `fl_bluegray`, `fl_bluegreen`, `fl_blueslab`, `fl_fake_trigger`, `fl_hay`, `fl_ivory`, `fl_marble`, `fl_platinum`, `fl_red`, `fl_redslab`, `fl_rough*`, `fl_tigris`, `fl_woven`.

All floors that look like wood are burnable and leave Section 7.4.1 [fl_abyss], page 166, behind: `fl_bast`, `fl_plank`, `fl_samba*`, `fl_wood*`, and Section 7.4.2 [fl_bridge], page 167_b*.

All floors that look like grass are burnable and leave Section 7.3.12 [fl_dunes], page 157, behind: Section 7.3.17 [fl_lawn], page 159.

All other floors are fireproof (they don't burn by default): `fl_abyss*`, `fl_brick`, `fl_bright`, `fl_concrete`, `fl_dark`, `fl_darkgray`, `fl_dummy`, `fl_dunes`, `fl_gravel`, `fl_gray`, `fl_himalaya`, `fl_ice`, `fl_inverse*`, `fl_metal*`, `fl_mortar`, `fl_pinkbumps`, `fl_rock`, `fl_sahara`, `fl_sand`, `fl_slope*`, `fl_space`, `fl_stone`, `fl_swamp`, `fl_water`, `fl_white`, `fl_yinyang*`, and Section 7.4.2 [fl_bridge], page 167_g*.

An open Section 7.4.2 [fl_bridge], page 167, is never burnable, this overrides all items and attributes. A closed Section 7.4.2 [fl_bridge], page 167, is burnable if and only if it is brown, but this can be changed via attribute `burnable`. Note that changing the flavor of Section 7.4.2 [fl_bridge], page 167, will change `burnable` according to the new flavor as well.

Fireproof Items

Most items are passively burnable, this is: An item is destroyed by fire, if and only if the floor could burn all by itself. However, there are some items with individual reactions (`it_burnable`, `it_burnable_oil`, `it_dynamite`, `it_bomb*`, `it_crack*`) and some items that are completely fireproof. These are: `it_burnable_ash`, `it_burnable_fireproof`, `it_debris`, `it_dummy`, `it_explosion*`, `it_extinguisher`, `it_extinguisher_medium`, `it_meditation*`, `it_trap`, `it_vortex*` and the fire animations themselves: `it_burnable_ignited` and `it_burnable_burning`.

Note that `it_extinguisher_empty`, `it_trigger` (visible and invisible), `it_landmine`, and `it_death` are passively burnable. In particular, `it_landmine` does not explode or create `it_meditation` when burning. The reaction of Section 8.4.12 [it_sensor], page 221, towards fire might be changed in future versions.

If you need to save a passively burnable item from fire, simply set a fireproof floor like `fl_sand` or `fl_rock` below it. This normally is the case when using Section 8.4.16 [it_strip], page 224. However, you can use the `burnable`-attribute in these cases to force burnability of the floors.

13.2.4 Heat-Transformation

When a fire starts to burn near Section 7.4.6 [fl_ice], page 172, it melts to Section 7.4.13 [fl_water], page 178. In the same sense, Section 7.4.13 [fl_water], page 178, boils to Section 7.4.11 [fl_swamp], page 177, and this again to Section 7.3.12 [fl_dunes], page 157. In contrast to most other fire-related actions, this is not random, but always and only happens, when a nearby fire starts to burn, i.e. once for each new fire.

Examples: Put an Section 9.5.7 [st_box], page 248_rock on Section 7.4.6 [fl_ice], page 172. A fire will melt the ice, and Section 9.5.7 [st_box], page 248_rock creates a fireproof and safe way to the other side. If you use Section 9.5.7 [st_box], page 248_wood instead, Section 7.4.14 [fl_wood], page 179_framed is created, which presumably catches fire and leaves Section 7.4.1 [fl_abyss], page 166, behind. Finally, Section 9.5.7 [st_box], page 248_hay will create Section 7.4.5 [fl_hay], page 171_framed, which is burnable, but won't burn down to Section 7.4.1 [fl_abyss], page 166. A similar combination is `fl_water` with Section 9.5.13 [st_chess], page 252.

You can enforce a transformation by sending the `heat`-message to the floor.

If you want to suppress this transformation, you can switch to a non-Enigma-compatibility-mode.

13.2.5 Freeze Checking

With Enigma 1.1 and above, you can use a special feature to support Sokoban levels and Sokoban parts of levels: Whenever a movable stone is pushed into some unmovable position, this feature automatically transforms the stone into Section 9.5.16 [st_death], page 255, to demonstrate that the game is lost and provide a simple way for the player to restart.

The feature is called "Freeze Checking". It applies to each stone with attribute `freeze_check = true` which is pushed onto a floor with attribute `freeze_check = true`. This way you can restrict the freeze check to a bounded area. For a true Sokoban the goal tiles should not be marked with `freeze_check = true`, as a frozen box on a goal is not considered harmful. On the other hand, you can specify which boxes are freeze-checked. This gives further freedom to use other stones inside your Sokoban area: Floor and stone both need the `freeze_check`-attribute activated.

The freeze check recognizes three basic constellations of stones that lead to a freeze of a standard movable stone. With `B` as box (movable or persistent) and `#` as wall (persistent):

```
BB   #B   #B
BB    #    B#
```

There are more freeze constellations which are not recognized, the simplest would be:

```
#B
 BB
  #
```

Don't rely on this fact, it might be changed in future versions.

Please bear in mind: The freeze check is not intelligent. It can't foresee that one of your functions might remove a stone, it can't foresee that some door will never open up again (doors are considered as non-existent), it doesn't recognize when you put an Section 8.3.23 [it_puller], page 200, Section 8.3.6 [it_cherry], page 188, or Section 9.5.63 [st_swap], page 306, in your level. It handles special stones in a way to minimize false-positive freeze checks.

Floating stones (like Section 9.5.27 [st_grate], page 266) create completely new frozen constellations. From the following two examples, only the right example is frozen (`G` is `st_grate_cross`):

```
G    G
BB   BB
GB   GBG
```

At present, none of these are recognized as frozen by Enigma, floating stones are considered as non-existing during a freeze check. To demonstrate the difficulty, you may analyze yourself which of the following constellations is frozen:

```
G     G     GBG   GB#   G G#G
B#   BBB    BB    GB G  BBBBB
G   #B B#  #B      G    G#G G
     G G    G
```

In some cases, stones are even handled differently although they have similar properties: Section 9.5.7 [st_box], page 248_wood and `st_flat_moveburnable` (see Section 9.5.23 [st_flat], page 262) are both movable and both destroyed by fire (see Section 13.2.3 [Fire Spreading], page 392). There would never be frozen stones, as they can easily be burned away. Yet, `st_box_wood` uses the default freeze checking, whereas `st_flat_moveburnable` is considered as non-existing. This is because `st_box_wood` is often used without fire, whereas `st_flat_moveburnable` is primarily used in combination with fire.

Another example is Section 9.5.59 [st_shogun], page 300_s, which is considered as a default movable stone, in contrast to the remaining shogun stones. This way you can use `st_shogun_s` with goal Section 8.4.13 [it_shogun], page 222_s, but don't have to fear false-positive freeze checks from the non-standard way in which shogun stones move.

As a concluding remark, the freeze checking is to be used as a support for the gamer only. It's not meant to be exploited as special feature to make movable stones unmovable or to provide a way to jump back to the starting position. It is subject to changes in future versions. And versions before 1.1 won't make a freeze check at all - so you can't rely on it to happen. It should really be used in Sokoban-kind parts of a level only, for which it is designed.

13.3 Tips and Tricks

13.3.1 Nearest Object Clustering

The nearest object as described in Section 4.2.3 [Object Naming], page 50, provides a major feature for reducing the number of needed tile declarations. As the selection needs to be unique a rule had to be defined in case of equal distances. South wins, then east, stones are favored to items, floors and actors.

In most cases level authors can arrange their objects to fit these rules. But sometimes the level design does not allow the straight forward usage of a simple nearest object selection. E.g.

```
ti["F"] = {"st_floppy", target="@door#*"}
ti["B"] = {"st_blocker", name="door#"}
wo{ti, " ", {
"      B           ",
"      FB#####FB####",
"      # F    B     ",
"      # #    F#####",
```

In both cases the floppy switch that is located at the crossing of two blocker doors will open the false one.

But you can use a cluster concept like the one we introduced for Section 9.4 [Cluster Stones], page 239. Just add one or in rare cases two or three additional groups. Assign all standard cases to group A and the out of line cases in group B:

```
ti["F"] = {"st_floppy", target="@doorA#*"}
```

```
ti["B"] = {"st_blocker", name="doorA#"}
ti["f"] = {"st_floppy", target="@doorB#*"}
ti["b"] = {"st_blocker", name="doorB#"}
wo{ti, " ", {
"       b           ",
"       fB#####fb####",
"       # F    B     ",
"       # #    F#####",
```

By clustering the doors in two groups you just need two additional tile declarations. But you will likely be able to handle a dozen of additional switch/door combinations.

13.3.2 Orthogonal Autotiling

Autotiling is useful whenever you want to define lots of target-action-pairings, even when source and target objects differ (i.e. use different tile keys). In this case we speak of '`orthogonal autotiling`'. Let's take a look at the important parts of the API 2 version of the level '`Laser Games`':

```
...
ti["T*"] = {"it_trigger", target = "mirror%%", action_1 = "turn", action_0 = "turnback
ti["F*"] = {"st_fourswitch", target = "mirror%%"}
ti["1*"] = {"st_mirror", name = "mirror%%", flavor = "triangle", orientation = NORTH}
ti["2*"] = {"st_mirror", name = "mirror%%", flavor = "triangle", orientation = SOUTH}
ti["3*"] = {"st_mirror", name = "mirror%%", orientation = NORTH}
...

local resolver = res.autotile(ti, {"T", "T*"}, {"F", "F*"},
    {"1", "1*"}, {"2", "2*"}, {"3", "3*"}, {"4", "4*"}, {"5", "5*"},
    {"6", "6*"}, {"7", "7*"}, {"8", "8*"}, {"9", "9*"})

w, h = wo(resolver, "  ", {
"# # # # # # # # # # # $ # $ # $ # $ # # ",
"#                 #                   # ",
"#     =   =       #   1a  9b  3c  2d  $ ",
"#             =   #                   # ",
"#     TaTbTcTd    #   3e  4f  5g  4h  $ ",
"#     TeFfFgTh    #                   # ",
"#     TiFjFkTl    #   6i  3j  4k  7l  $ ",
"#     TmFnFoTp    #                   # ",
"#     TqTrTsTt    #   8m  7n  6o  8p  $ ",
"#                 #                   # ",
"#       @   =     #   1q  7r  3s  2t  $ ",
"#                 #                   # ",
"# # # # # # # # # # # $ # $ # $ # ^ # # "
})
...
```

We have different kinds of sources for our actions (triggers `T` and fourswitches `F`), and different kinds of targets (mirrors `1`, `2` etc.). However, as all mirrors are consistently named mirror%%, with %% being replaced by %a to %t, the connections between the objects can be set easily without having to worry about different object types: The trigger Ta will turn mirror 1a (which is called mirror%a), Tb will turn 9b and so on. If we decide to replace mirror 1a by, say, mirror type 2, we can simply replace 1a by 2a, and still preserve the action-target-pairing.

In this very special situation, the attribute counterclock proves to be useful: All mirrors in this level turn clockwise, except for 9b. Without counterclock, we'd have to use a callback-function to decide about the target and manually choose between the actions turn and turnback. However, by setting

```
ti["9*"] = {"st_mirror", name = "mirror%%", flavor = "triangle",
                         orientation = SOUTH, counterclock = true}
```

it's possible to send the same messages to all mirrors that correspond to triggers (i.e. turn when the trigger is pressed down and turnback when it is released again), and still to have one or more mirrors behave in a different way (i.e. rotating in another direction). The inverse attribute is of a similar use.

14 Extension Development

14.1 Resolver Development

Resolvers are designed to provide easy pluggable extensions for usage by level authors. Further on resolvers should be as flexible as possible. To reach these goals each resolver consists of three parts: the configurator, the implemention and the finalizer.

14.1.1 Resolver Configurator

The configurator is the function that is being called, when the author supplies the resolver specific parameters.

Syntax: context = **res.resolvername**(*subresolver*,...)

subresolver
: Resolver to which unresolved requests should be forwarded. May be '`ti`' as the final resolver of the resolver chain.

Details: This function has just one mandatory parameter, the subresolver. You are free to specify arbitrary further parameters due to the needs of the resolvers task.

All official resolvers will be registered in the registry table '`res`' under their official name:

```
function res.composer(subresolver)
    ...
end
```

This configurator function will be called just once per level start. It is called after the tile declarations and before the first tile is set and the implementation part may be called.

It is the task of the configurator function to check the user supplied parameters thoroughly and to provide appropriate error messages on bad parameters. Do this with a lua error message call at level 2 or the useful helper functions Section 5.14.1 [assert_bool], page 118, and Section 5.14.2 [assert_type], page 118:

```
error("Resolver autotile rule " .. i.." is not a table", 2)
assert_bool(is_resolver(subresolver), "res.composer first argument (subresol
assert_type(args[1], "res.composer second argument (sequence)", 2, "non-empt
```

The configuration function has to return a table that contains the context for subsequent calls of the implementation. This table has three predefined entries:

[1] = *implementation function*
[2] = *finalizer function*
[3] = *subresolver*
... = resolver specific additional entries

All the checked and preprocessed parameters have to be stored in this context table for later usage. The resolver implementation function is usually registered as '`res.resolvername_implementation`'. The finalizer can be '`nil`' if no finalization is necessary. The subresolver given as the first parameter of the configurator call needs to be the third context table entry.

The context needs to add a metatable with two entries. First `"_type"` needs to identify the context as an enigma data type for the Section 5.14.4 [etype], page 121, function. Most resolvers do simply store the string `"resolver"`, but special ones might return special identification strings like `"maze"`. The second required entry is `"_resolver"` that needs a boolean '`true`' value assigned for purpose of secure identification of resolver tables. A default resolver metatable is stored at '`res.metatable`' and can directly be set by '`setmetatable`'.

Full Example:

```
function res.composer(subresolver)
    assert_bool(is_resolver(subresolver), "res.composer first argument (subr
    local context = {res.composer_implementation, nil, subresolver}█
    setmetatable(context, res.metatable)
    return context
end
```

14.1.2 Resolver Implementation

When the map gets evaluated on the world creation the top resolver is asked for every key to return the valid tile declaration. This is done with the following call.

Syntax: tile = **resolver_implementation**(*context*, *evaluator*, *key*, *x*, *y*)

context	The context as provided as return value by the Section 14.1.1 [Resolver Configurator], page 399.
evaluator	A system function that needs to be called whenever this resolver needs to look up the key by its subresolver.
key	The key string that should be resolved
x, *y*	The position of the tile.

Details: Based on the given parameters, the key, the position, the resolver parameters stored in the context and the existing tiles that can be requested via the evaluator function the implementation needs to decide if it takes influence on the key. Note that it is not possible to access any world object via its coordinates at this time. On every call you have to assume that it may be the first tile that is set.

If the key is not resolved to a final tile by this resolver, the subresolver must be called via the evaluator function:

```
local tile = evaluator(context[3], key, x, y)
```

Remember that the subresolver is stored at position 3 of the context. As no influence should be taken this tile is the one that should be returned.

But if you want to return another tile you are free to do it. You can decide on another key and ask the subresolver for the appropriate tile. You can even concatenate two tiles returned by subsequent subresolver calls. You are allowed to return a new tile with a table declaration of an object. Some valid return statements:

```
return evaluator(context[3], "a", x, y)
return evaluator(context[3], "a", x, y) .. evaluator(context[3], "b", x, y)█
return evaluator(context[3], "a", x, y) .. ti({"st_laser_n", state=ON})
```

You are even allowed to add new tile declarations to the tiles repository to speed up subsequent calls:

```
ti["newkey"] = evaluator(context[3], "a", x, y) .. ti({"st_laser_n", state=O
```

A resolver implementation can store and modify any of its private parameters in the context table for subsequent calls. Especially it can enlist all coordinates for postprocessing operations in the finalizer.

Full Example:

The implementation of the composer (without the special sequence treatment)

```
function res.composer_implementation(context, evaluator, key, x, y)
    local tile = evaluator(context[3], key, x, y)
    if tile ~= nil then
        return tile
    end
    -- try to compose tile
    for i = 1, #key do
        local subkey = string.rep(" ", i-1) .. string.sub(key, i, i) .. stri
        local subtile = evaluator(context[3], subkey, x, y)
        if subtile == nil then
            return nil
        end
        if tile == nil then
            tile = subtile
        else
            tile = tile .. subtile
        end
    end
    return tile
end
```

14.1.3 Resolver Finalizer

If the Section 14.1.1 [Resolver Configurator], page 399, provides a finalizer function in its context this function will be called once when all tiles from the map have been set.

Syntax: **resolver_finalization**(*context*)

context The context as provided as return value by the Section 14.1.1 [Resolver Configurator], page 399.

Details: The finalization functions of chained resolvers are called from bottom to top.

Many resolvers have no need of a finalization. But some like a maze constructor need to know all participating tiles until they can do their final work.

As all tiles from the map have been processed the objects can now be accessed. Further information may be stored in the resolver's context.

The finalizer does neither call its subresolver nor does it return a value.

15 Guidelines and Hints

Up to now we described all features in their full extend. Of course you are free to use them all without any restrictions for your private levels. We are committed to maintain all features in future versions of Enigma.

But for inclusion of your levels into the Enigma project we would like to recommend conformance to some common standards. These few points guarantee that your levels can easily be processed by our administration tools, the players can talk about your level and your level remains editable by the project maintainers in case of urgent need.

Additionally we like to give you some hints how to write good levels by means of proper strategy.

15.1 Filename Recommendation

No space for spaces

15.2 Title Recommendation

English titles preferred - use subtitle, too

15.3 Tile Key Recommendation

The following guidelines are not compulsory, but we nevertheless encourage them, as they ease the development of new and the maintenance of old levels.

- Stones use capital letters, items small letters, floors use punctuation marks.
- The default floor is `" "`. The second most important floor typically is `"_"` or `"."`. It's a good idea to use tile keys for floors, which are small and don't obstruct the view on the more important objects, like stones and items. Important floors (like bridges) may have letters or numbers to emphasize their importance (a bridge could be `"b"`, or a number to use autotiling).
- Water typically is `"~"`, as the tilde is a small character which resembles a wave. Similarly, an abyss can be well described by `"_"`, as the underscore resembles a hole.
- On a German keyboard, the four characters `"."`, `","`, `":"` and `";"` are arranged in a square, so you can easily use them to arrange quadruples of floors, like lawn pieces of different brightness. On a US keyboard, you can use `","`, `"."`, `"<"` and `">"` to the same purpose. Another quadruple of characters are the arithmetic operators `"+"`, `"-"`,`"*"`, and `"/"`.
- Slopes can be described using `"<"`, `">"`, `"v"` and `"^"`. As you see, we encourage you to use the letter `"v"` for a floor at this point, as it resembles an arrow pointing down. For slant slopes, it's a good idea to use either numbers (following the number keypad on your keyboard), or quadruple characters like `"."`, `","`, `":"`, `";"` or arithmetic operators.
- Although it fits nicely to `"/"`, it's not a good idea to use the backslash as a tile key, as it has to be masked to work correctly. Similarly, we disencourage the use of brackets as tile keys.
- The most important simple stone should be `"#"`, all other stones should use their first letter, like "laser" `->` `"L"`, "switch" `->` `"S"`, "box" `->` `"B"`. If two stones have the same

first letter, the more important one should be given priority (`"L"` for laser instead of `"L"` for `"st_lightglass"`, `"G"` for `"st_lightglass"` instead of `"G"` for `"st_greenbrown"`).

- Orientable stones like boulders or lasers should use `"N"`, `"E"`, `"S"`, `"W"` if they appear in more than one orientation.
- Stones of the same kind, which appear several times in different ways (like switches with different actions) should use consecutive letter (`"S"`, `"T"`, `"U"`, ...) or numbers.
- Oxyd stones should use `"O"` or `"0"`. If you put several different oxyd stones, e.g. of different colors, make use of consecutive letters (`"P"`, `"Q"`, `"R"` ...) or numbers.
- If you want to put mirrors, it's a good idea to use characters resembling the orientation of the mirror, i.e. `"|"`, `"-"`, and `"/"`. As the backslash is no good tile key, you may use `"&"` or `"Q"` instead, as these characters include a prominent slant line similar to the backslash. Triangular mirrors are best written with `"<"`, `">"`, `"v"` and `"^"`.
- For rotator stones, it's a good idea to use `"R"` and `"L"` for clockwise (right) and counter-clockwise (left) rotating stones. As an alternative, you might want to use characters which are written in either clockwise or counter-clockwise manner, like `"p"` and `"q"`. Note that this might depend on your handwriting.
- Documents can use either `"d"`, or `"i"` (for `"information"`), as `"d"` is used more often (e.g. for autotiling purposes). If several documents appear in the level, you can use consecutive letters (`"i"`, `"j"`, `"k"` ...). Remember that you can take advantage of autotiling if you have lots of different documents in your level.
- Coins can be written with `"c"`, with `"$"` or with numbers resembling their worth.
- Marbles should be `"@"`, all other actors should use small letters (`"t"` for ac_top, `"p"` for ac_pearl, ...), or large punctuation marks.
- For autotiling, it's a good idea to use `"X"`, `"Y"`, `"x"`, `"y"`, `"*"`, `"?"` and similar characters which associate themselves with variables as template keys. Another possibility is to use a full word like `"door"` or `"switch"` as template tile key, which has the advantage of being easier

15.4 Easy Mode Hints

write easy first, floor friction,...

16 Compatibility

16.1 Engine Compatibility

Although Enigma was inspired by the Oxyd game series, there are some differences between the native Enigma engine mode and the other modes as well as between the other modes themselves. Using the compatibility element of the xml-metadata (see Section 3.3.6 [<compatibility>], page 33), it is possible to activate some of these special features. Here is a list of the major differences

All non-Enigma modes (`oxyd1`, `per.oxyd`, `oxyd.magnum`, `oxyd.extra`)

- Keep Section 8.3.18 [it_key], page 196, when using Section 9.5.32 [st_key], page 271.
- Oxyd stones (Section 9.5.44 [st_oxyd], page 284) must blink before they can be ultimately opened (pairs must be hit with some time delay).
- The non-Enigma modes feature a model of the 0.92-Fire System (see Section 13.2.3 [Fire Spreading], page 392).
- Section 8.4.15 [it_squashed], page 224, and Section 8.4.5 [it_cross], page 215, can't be removed with Section 8.3.5 [it_brush], page 188.
- The only function of Section 8.3.20 [it_pencil], page 198, is to turn Section 9.5.23 [st_flat], page 262, and its movable variant into the burnable variants.
- Section 8.3.3 [it_bottle], page 186, doesn't break when a stone is pushed over it.
- Section 9.5.63 [st_swap], page 306, and Section 9.5.51 [st_pull], page 291, may not swap/pull into the level border.

`oxyd1`**-compatibility**

- Section 8.3.26 [it_seed], page 203, grows to Section 7.4.14 [fl_wood], page 179_framed under Section 9.5.27 [st_grate], page 266_cross, not to Section 9.5.7 [st_box], page 248_wood.
- Flying actors may pass Section 9.5.27 [st_grate], page 266).
- Section 9.5.7 [st_box], page 248_wood only falls when moved.
- The `ignite`-message (e.g. by Section 8.3.11 [it_dynamite], page 192) doesn't kill Section 8.3.9 [it_document], page 190.
- Bombs Section 8.4.2 [it_bomb], page 211, aren't ignited when Section 9.5.7 [st_box], page 248_wood is pushed over them (see `oxydmagnum`-compatibility).

`per.oxyd`**-compatibility**

- When painted with Section 8.3.5 [it_brush], page 188, Section 9.5.26 [st_ghost], page 265_purplemarble becomes an open Section 9.5.21 [st_fake], page 260_oxydc instead of `st_purplemarble`.
- Section 8.3.17 [it_hammer], page 196, doesn't laser-transform into Section 8.3.31 [it_sword], page 206.
- Section 8.3.32 [it_umbrella], page 207, doesn't explode in laser light.
- Section 8.4.5 [it_cross], page 215, inverts signals it receives.

`oxyd.magnum`-**compatibility**

- Section 8.3.26 [it_seed], page 203, grows to Section 7.4.14 [fl_wood], page 179_framed under Section 9.5.27 [st_grate], page 266_cross, not to Section 9.5.7 [st_box], page 248_wood.
- BombsSection 8.4.2 [it_bomb], page 211, aren't ignited when Section 9.5.7 [st_box], page 248_wood is pushed over them (see `oxyd1`-compatibility).

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(Index is nonexistent)

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