

The luamplib package

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Abstract

Package to have METAPOST code typeset directly in a document with LuaTeX

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1 Documentation

This package aims at providing a simple way to typeset directly METAPOST code in a document with Lua \TeX . Lua \TeX is built with the Lua `mplib` library, that runs METAPOST code. This package is basically a wrapper for the Lua `mplib` functions and some \TeX functions to have the output of the `mplib` functions in the PDF.

Using this package is easy: in Plain, type your METAPOST code between the macros `\mplibcode` and `\endmplibcode`, and in \LaTeX in the `mplibcode` environment.

The resulting METAPOST figures are put in a \TeX hbox with dimensions adjusted to the METAPOST code.

The code of `luamplib` is basically from the `luatex-mplib.lua` and `luatex-mplib.tex` files from Con \TeX t. They have been adapted to \LaTeX and Plain by Elie Roux and Philipp Gesang and new functionalities have been added by Kim Dohyun. The most notable changes are:

- Possibility to use `btex` . . . `etex` to typeset \TeX code. `texttext` $\langle string \rangle$ is a more versatile macro equivalent to `TEX` $\langle string \rangle$ from `TEX.mp`. `TEX` is also allowed and is a synonym of `texttext`. The argument of `mplib`'s primitive `maketext` will also be processed by the same routine.

- Possibility to use `verbatimtex ... etex` to run a \TeX code. `VerbatimTeX` $\langle string \rangle$ is a more versatile macro corresponding to `verbatimtex` command. Of course the behavior cannot be the same as the stand-alone `mpost`, so that you cannot include `\documentclass`, `\usepackage` etc. When these \TeX commands are found in `verbatimtex ... etex`, the entire code will be ignored.

The treatment of `verbatimtex` command has changed a lot since v2.20: see below § 1.1.6.

- In the past, the package required PDF mode in order to have some output. Starting with v2.7 it works in DVI mode as well, though `DVIPDFMx` is the only DVI tool currently supported.

It seems to be convenient to divide the explanations of some more changes and cautions into three parts: \TeX , `METAPOST`, and Lua interfaces.

1.1 \TeX

1.1.1 `\mplibforcehmode`

When this macro is declared, every `METAPOST` figure box will be typeset in horizontal mode; so `\centering`, `\raggedleft` etc. will have effects. `\mplibnoforcehmode`, being default, reverts this setting.¹

1.1.2 `\everymplib{...}, \everyendmplib{...}`

`\everymplib` and `\everyendmplib` redefine the Lua table entry containing `METAPOST` code which will be automatically inserted at the beginning and ending of each `METAPOST` code chunk.

```
\everymplib{ beginfig(0); }
\everyendmplib{ endfig; }
\begin{mplibcode}
  % beginfig/endfig not needed
  draw fullcircle scaled 1cm;
\end{mplibcode}
```



1.1.3 `\mplibsetformat{plain|metafun}`

There are (basically) two formats for `METAPOST`: *plain* and *metafun*. By default, the *plain* format is used, but you can set the format to be used by future figures at any time using `\mplibsetformat{<format name>}`.

N.B. As *metafun* is such a complicated format, we cannot support all the functionalities producing special effects provided by *metafun*. At least, however, transparency (actually opacity), shading (gradient colors) and transparency group are fully supported, and `outlinetext` is supported by our own alternative `mpliboutlinetext` (see below § 1.2.10). You can try other effects as well, though we did not fully tested their proper functioning.

¹Actually these commands redefine `\prependtomplibbox`. So you can redefine this macro with anything suitable before a box. But see § 1.1.18 on Tagged PDF.

transparency (texdoc metafun §8.2) Transparency is so simple that you can apply it to an object, with *plain* format as well as *metafun*, just by appending withprescript "tr_transparency=<numeric>" to the sentence. ($0 \leq \langle \text{numeric} \rangle \leq 1$)

From v2.36, withtransparency is available with *plain* format as well. See below § 1.2.4.

shading (texdoc metafun §8.3) One thing worth mentioning about shading is: when a color expression is given in string type, it is regarded by luamplib as a color expression of T_EX side. For instance, when withshadecolors("orange", 2/3red) is given, the first color "orange" will be interpreted as a color, xcolor or l3color's expression.

From v2.36, shading is available with *plain* format as well with extended functionality. See below § 1.2.5.

transparency group (texdoc metafun §8.8) As for transparency group, the current *metafun* document is not correct. The true syntax is:

```
draw <picture>|<path> asgroup <string>
```

where <string> should be "" (empty), "isolated", "knockout", or "isolated,knockout". Beware that currently many of the PDF rendering applications, except Adobe Acrobat, cannot properly render the isolated or knockout effect.

Transparency group is available with *plain* format as well with extended functionality. See below § 1.2.12.

1.1.4 \mplibnumbersystem{scaled|double|decimal}

Users can choose numbersystem option. The default value is scaled, which can be changed by declaring \mplibnumbersystem{double} or \mplibnumbersystem{decimal}.

1.1.5 \mplibshowlog{enable|disable}

Default: disable. When \mplibshowlog{enable}² is declared, log messages returned by the METAPOST process will be printed to the .log file. This is the T_EX side interface for luamplib.showlog.

1.1.6 \mpliblegacybehavior{enable|disable}

Legacy behavior By default, \mpliblegacybehavior{enable} is already declared for backward compatibility, in which case T_EX code in verbatimtex ... etex that comes just before beginfig() will be inserted before the following METAPOST figure box. In this way, each figure box can be freely moved horizontally or vertically. Also, a box number can be assigned to a figure box, allowing it to be reused later.³

```
\mplibcode
verbatimtex \moveright 3cm etex; beginfig(0); ... endfig;
```

²As for user's setting, enable, true and yes are identical; all others are identical to disable.

³But the recommended way to reuse a figure is using \mplibgroup command. See below § 1.2.13.

```

verbatimtex \leavevmode etex; beginfig(1); ... endfig;
verbatimtex \leavevmode\lower 1ex etex; beginfig(2); ... endfig;
verbatimtex \endgraf\moveright 1cm etex; beginfig(3); ... endfig;
\endmplibcode

```


N.B. `\endgraf` should be used instead of `\par` inside `mplibcode` environment.

On the other hand, \TeX code in `verbatimtex ... etex` between `beginfig()` and `endfig` will be inserted after flushing out the `METAPOST` figure. An example:⁴

```

\mplibcode
D := sqrt(2)**9;
beginfig(0);
  draw fullcircle scaled D;
  VerbatimTeX("\gdef\Dia{" & decimal D & "}");
endfig;
\endmplibcode
diameter: \Dia bp.

```



diameter: 22.62764bp.

New and recommended way By contrast, when `\mpliblegacybehavior{disable}` is declared, any `verbatimtex ... etex`, along with `btex ... etex`, will be run sequentially one by one. So, some \TeX code in `verbatimtex ... etex` will have effect on `btex ... etex` codes thereafter.

```

\begin{mplibcode}
beginfig(0);
  draw btex ABC etex;
  verbatimtex \bfseries etex;
  draw btex DEF etex shifted (1cm,0); % bold face
  draw btex GHI etex shifted (2cm,0); % bold face
endfig;
\end{mplibcode}

```

ABC DEF GHI

1.1.7 `\mplibtexttextlabel{enable|disable}`

Default: `disable`. `\mplibtexttextlabel{enable}` enables the labels typeset via `texttext` instead of `infont` operator. So, `label("my text", origin)` thereafter is exactly the same as `label(texttext "my text", origin)`.

N.B. In the background, `luamplib` redefines `infont` operator so that the right side argument (the font part) is totally ignored. Therefore the left side argument (the text part) will be typeset with the current \TeX font.

From v2.35, however, the redefinition of `infont` operator has been revised: when the character code of the text argument is less than 32 (control characters), or is equal to 35 (#), 36 (\$), 37 (%), 38 (&), 92 (\), 94 (^), 95 (_), 123 ({), 125 (}), 126 (~) or 127 (DEL), the original `infont` operator will be used instead of `texttext` operator so that the font part will be honored. Despite the revision, please take care of `char` operator in the text argument, as this might bring unpermitted characters into \TeX .

⁴But the recommended way to access `METAPOST` variables from \TeX (or Lua) side is to use Lua code via `luamplib`.instances. For details see below § 1.3.2.

1.1.8 `\mplibcodeinherit{enable|disable}`

Default: `disable`. `\mplibcodeinherit{enable}` enables the inheritance of variables, constants, and macros defined by previous `METAPOST` code chunks. On the other hand, `\mplibcodeinherit{disable}` will make each code chunk being treated as an independent instance, never affected by previous code chunks.

1.1.9 `\mplibglobaltexttext{enable|disable}`

Default: `disable`. Formerly, to inherit `btex ... etex` boxes as well as other `METAPOST` macros, variables and constants, it was necessary to declare `\mplibglobaltexttext{enable}` in advance. But from v2.27, this is implicitly enabled when `\mplibcodeinherit` is enabled. The command still remains mostly for backward compatibility.

```
\mplibcodeinherit{enable}
%\mplibglobaltexttext{enable}
\everymplib{ beginfig(0);} \everyendmplib{ endfig;}
\mplibcode
  label(btex  $\sqrt{2}$  etex, origin);
  draw fullcircle scaled 20;
  picture pic; pic := currentpicture;
\endmplibcode
\mplibcode
  currentpicture := pic scaled 2;
\endmplibcode
```



1.1.10 Separate `METAPOST` instances

`luamplib` v2.22 has added the support for several named `METAPOST` instances in \LaTeX environment `mplibcode` or Plain \TeX commands `\mplibcode ... \endmplibcode`. The syntax for \LaTeX is:

```
\begin{mplibcode}[instanceName]
  % some mp code
\end{mplibcode}
```

The behavior is as follows.

- All the variables and functions are shared only among all the environments belonging to the same instance.
- `\mplibcodeinherit` only affects the environments with no instance name set (since if a name is set, the code is intended to be reused at some point).
- `btex ... etex` boxes are also shared and do not require `\mplibglobaltexttext`.
- When an instance names is set, respective `\currentmpinstancename` is set as well.

In parallel with this functionality, we support optional argument of instance name for `\everymplib` and `\everyendmplib`, affecting only those `mplibcode` environments of the same name.

Unnamed `\everymplib` affects not only those instances with no name, but also those with name but with no corresponding `\everymplib`. The syntax is:

```
\everymplib[instanceName]{...}
\everyendmplib[instanceName]{...}
```

1.1.11 `\mplibverbatim{enable|disable}`

Default: `disable`. Users can issue `\mplibverbatim{enable}`, after which the contents of `mplibcode` environment will be read verbatim. As a result, except for `\mpdim` and `\mpcolor` (see § 1.1.12 and § 1.1.13), all other \TeX commands outside of the `btex` or `verbatimtex ... etex` are not expanded and will be fed literally to the `mplib` library.

1.1.12 `\mpdim{...}`

Besides other \TeX commands, `\mpdim` is specially allowed in the `mplibcode` environment. This feature is inspired by `gmp` package authored by Enrico Gregorio. Please refer to the manual of `gmp` package for details.

```
draw origin--(.4\mpdim{\linewidth},0)
  withpen pencircle scaled 4 dashed evenly scaled 4
  withcolor \mpcolor{orange}
;
```



1.1.13 `\mpcolor[...]{...}`

With `\mpcolor` command, color names or expressions of color, `xcolor` and `l3color` module/packages can be used in the `mplibcode` environment (after `withcolor` command, in principle). See the example above at § 1.1.12. The optional [...] denotes the option of `xcolor`'s `\color` command. For spot colors, `l3color` (in PDF/DVI mode), `colorspace`, `spotcolor` (in PDF mode) and `xespotcolor` (in DVI mode) packages are supported as well.

N.B. Formerly, only the first object would have been colored as intended among multiple graphical objects in a `METAPOST` image, because `\mpcolor` always produced `withprescript` command internally. Since v2.38.1, now that `\mpcolor` returns a `METAPOST` color expression if possible, users can issue the sentence as follows without worrying about the location of the color command:

```
draw image (drawarrow (left--right) scaled 5)
  scaled 7
  withcolor \mpcolor{red!50}
;
```



Be aware, however, that even after v2.38.1 `\mpcolor` will still insert the `withprescript` command when the color specified is a spot color (or named color in DVI mode). Users therefore have to revise the code so that the color can have effect inside the image. For instance:

```
draw image (drawarrow (left--right) scaled 5 withcolor \mpcolor{spotA})
  scaled 7
;
```

1.1.14 `\mpfig ... \endmpfig`

Besides the `mplibcode` environment (for \LaTeX) and `\mplibcode ... \endmplibcode` (for Plain), we also provide unexpandable \TeX macros `\mpfig ... \endmpfig` and its starred version `\mpfig* ... \endmpfig` to save typing toil. The former is roughly the same as follows:

```
\begin{mplibcode}[@mpfig]
  beginfig(0)
    token list declared by \everymplib[@mpfig]
    ...
    token list declared by \everyendmplib[@mpfig]
  endfig;
\end{mplibcode}
```

and the starred version is roughly the same as follows:

```
\begin{mplibcode}[@mpfig]
  ...
\end{mplibcode}
```

In these macros `\mpliblegacybehavior{disable}` is forcibly declared. Again, as both share the same instance name, `METAPOST` codes are inherited among them. A simple example:

```
\everymplib[@mpfig]{ drawoptions(withcolor 1/3[red,white]); }
\mpfig* input boxes \endmpfig
\mpfig
  circleit.a(btex Box 1 etex); drawboxed(a);
\endmpfig
```

Box 1

Users can change the instance name (default value: `@mpfig`) by redefining `\mpfiginstancename`, after which a new `mplib` instance will start and code inheritance too will begin anew. `\let \mpfiginstancename\empty` will prevent code inheritance if `\mplibcodeinherit` is not true.

1.1.15 About cache files

To support `btex ... etex` in external `.mp` files, `luamplib` inspects the content of each and every `.mp` file and makes caches if necessary before returning their paths to the `mplib` library. This could waste the compilation time, as most `.mp` files do not contain `btex ... etex` commands. So `luamplib` provides macros as follows, so that users can give instructions about files that do not require this functionality.

- `\mplibmakenocache{⟨filename⟩[,⟨filename⟩,...]}`
- `\mplibcancelnocache{⟨filename⟩[,⟨filename⟩,...]}`

where `⟨filename⟩` is a filename excluding `.mp` extension. Note that `.mp` files under `$TEXMFMAIN/metapost/base` and `$TEXMFMAIN/metapost/context/base` are already registered by default.

By default, cache files will be stored in `$TEXMFVAR/luamplib_cache` or, if it's not available (mostly not writable), in the directory where output files are saved: to be specific,

`$TEXMF_OUTPUT_DIRECTORY/luamplib_cache`, `./luamplib_cache`, `$TEXMFOUTPUT/luamplib_cache`, and `.`, in this order. `$TEXMF_OUTPUT_DIRECTORY` is normally the value of `--output-directory` command-line option.

Users can change this behavior by the command `\mplibcachedir{<directory path>}`, where tilde (`~`) is interpreted as the user's home directory (on a windows machine as well). As backslashes (`\`) should be escaped by users, it would be easier to use slashes (`/`) instead.

1.1.16 About figure box metric

Notice that, after each figure is processed, the macro `\MPwidth` stores the width value of the latest figure; `\MPheight`, the height value. Incidentally, also note that `\MPllx`, `\MPlly`, `\MPurx`, and `\MPury` store the bounding box information of the latest figure without the unit bp.

1.1.17 luamplib.cfg

At the end of package loading, `luamplib` searches `luamplib.cfg` and, if found, reads the file in automatically. Frequently used settings such as `\everymplib`, `\mplibforcehmode` or `\mplibcodeinherit` are suitable for going into this file.

1.1.18 Tagged PDF

When `tagpdf` package is loaded and activated, `mplibcode` environment accepts additional options for tagged PDF. The code related to this functionality is currently in experimental stage, not guaranteeing backward compatibility. Available optional keys are similar to those of the \TeX 's picture environment (`texdoc latex-lab-graphic`). The default tagging mode is the `alt` key with Figure structure.

alt=`<text>` starts a Figure tag by default and sets an alternate text of the figure from the `<text>`.

BBox info will be added automatically to the PDF. This key is needed for ordinary METAPOST figures, for which, if no alt text is given, a default text will be used with a warning issued. You can change the alternate text within METAPOST code as well: `VerbatimTeX "\mplibalttext{<text>}"`;

actualtext=`<text>` starts a Span tag implicitly and sets a replacement text (a.k.a. actual text) from the `<text>`. If in vertical mode, horizontal mode will be forced by `\noindent` command.⁵

BBox info will not be added. This key is intended for figures which can be represented by a character or a small sequence of characters. You can change the actual text within METAPOST code as well: `VerbatimTeX "\mplibactualtext{<text>}"`;

artifact starts an Artifact MC (marked content). BBox info will not be added. This key is intended for decorative figures which have no semantic meaning.

text starts an Artifact MC but enables tagging on \TeX -text boxes (such as `btex ... etex`, excluding pictures made by `infont` operator). If in vertical mode, horizontal mode will be

⁵It is not recommended to personally redefine `\prependtomplibbox`. Apart from using `\mplibforcehmode` or `\mplibnoforcehmode`, the redefinition might be incompatible with `actualtext` key. See § 1.1.1 on these commands.

forced by `\noindent` command.⁶ BBox info will not be added. This key is intended for figures the meaning of which is the sequence of texts in the \TeX -text boxes in the order they are drawn in the figure. Inside text-mode figures, reusing \TeX -text boxes is strongly discouraged.

Note that the text in a \TeX -text box which starts with `[taggingoff]` will not be tagged at all, and of course `[taggingoff]` and its trailing spaces will be gobbled by `luamplib`. For example, the first and the third boxes in the following figure will not be tagged, and still remain in the Artifact MC-chunks.

```
\begin{mplibcode}[text]
  beginfig(1)
    draw btex [taggingoff]  $\sqrt{2}$  etex ;
    draw texttext " $\sqrt{3}$ " shifted 12down ;
    draw TEX "[taggingoff]  $\sqrt{5}$ " shifted 24down ;
    draw maketext " $\sqrt{7}$ " shifted 36down ;
    draw mplibgraphicstext " $\sqrt{x}$ " shifted 48down ;
  endfig;
\end{mplibcode}
```

off Given this key, nothing will be tagged by `luamplib`.

tag=⟨name⟩ You can choose a tag name, default value being Figure.⁷ For instance, you can set `'tag=Formula, alt=⟨text⟩'` to get a Formula element with its alternate text.⁸

adjust-BBox=⟨dimens⟩ You can correct the BBox attribute of the figure by space-separated four dimensional values, which will be added to the automatically calculated BBox values. To draw the bounding box for checking with half-transparent red color, you can add `debug=BBox` to the argument of `\DocumentMetadata` command.

tagging-setup=⟨key-val list⟩ This key accepts as its value the list of key-value options mentioned so far.

You can set these options anywhere in the document by declaring `\SetKeys[luamplib/tagging]{⟨key-val list⟩}`, which will affect `mplib` figures thereafter in the scope. And the options listed above are provided for `\mpfig` and `\usemplibgroup` (see [below § 1.2.12](#)) commands as well.

```
\begin{mplibcode}[myInstanceName, alt=drawing of a circle]
  ...
\end{mplibcode}

\mpfig[alt=drawing of a square box]
  ...
\endmpfig
```

⁶The key text also shares the limitation mentioned in the previous footnote.

⁷The option `tag=false`, however, is a synonym of the `off` key.

⁸Beware that this bypasses \TeX 's regular math formula tagging, for which the `text` key is needed.

```

\usemplibgroup[alt=drawing of a triangle]{...}

\mppattern{...}           % see below
\mpfig[off]               % do not tag this figure
...
\endmpfig
\endmppattern

```

As for the instance name of `mplibcode` environment, `instance=<name>` or `instancename=<name>` is also allowed in addition to the raw instance name as shown above.

1.2 METAPOST

1.2.1 `mplibdimen ...`, `mplibcolor ...`

These are METAPOST interfaces for the \TeX commands `\mpdim` and `\mpcolor` (see above § 1.1.12 and § 1.1.13). For example, `mplibdimen "\linewidth"` is basically the same as `\mpdim{\linewidth}`, and `mplibcolor "red!50"` is basically the same as `\mpcolor{red!50}`. The difference is that these METAPOST operators can also be used in external `.mp` files, which cannot have \TeX commands outside of the `btex` or `verbatimtex ... etex`.

1.2.2 `mplibtexcolor ...`, `mplibrgbtexcolor ...`

`mplibtexcolor`, which accepts a string argument, is a METAPOST operator that converts a \TeX color expression to a METAPOST color expression, that can be used anywhere color expression is expected as well as after the `withcolor` command.⁹ For instance:

```

color col;
col := mplibtexcolor "olive!50";

```

But the result may vary in its color model (gray/rgb/cmyk) according to the given \TeX color. Therefore the example shown above would raise a METAPOST error: `cmykcolor col;` should have been declared. By contrast, `mplibrgbtexcolor <string>` always returns rgb-model expressions.

N.B. Spot colors are forced to cmyk or rgb model, so these operators are not recommended for spot colors.

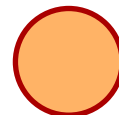
1.2.3 `withmplibcolors (... , ...)`

Unlike the `withcolor` command, users can specify one color for filling and another color for stroking using the macro `withmplibcolors` at the end of a sentence. The syntax is `withmplibcolors (<fill color expr>, <stroke color expr>)`. When the argument is in string type, it is regarded as the color expression of \TeX side. A simple example (see also the example at § 1.2.9):

```

filldraw fullcircle scaled 40
  withpen pencircle scaled 2
  withmplibcolors ("orange!60", 2/3red)
;

```



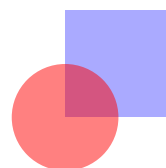
⁹Since v2.38.1, the operation of `mplibtexcolor` is the same as that of `mplibcolor` if the color specified is not a spot color or a named color in DVI mode.

The PDF file size is much smaller than issuing two sentences with different colors, though the apparent effect is the same.

1.2.4 withtransparency (... , ...)

`withtransparency(<number> | <string>, <numeric>)` is provided for *plain* format as well as *metafun*. The first argument accepts a number or a name of alternative transparency methods (see texdoc metafun § 8.2 Figure 8.1). The second argument accepts a numeric expression denoting opacity.

```
\mpfig
  fill unitsquare scaled 40
    withcolor 1/3[blue,white]
    withtransparency (1, 0.5)      % or ("normal", 0.5)
  ;
  fill fullcircle scaled 40
    withcolor red
    withtransparency (1, 0.5)
  ;
\mpfig
```

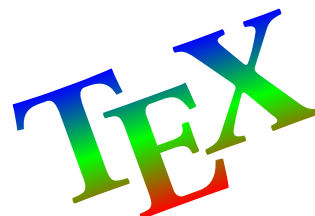


1.2.5 ... withshadingmethod ...

The syntax is exactly the same as *metafun*'s new shading method (texdoc metafun § 8.3.3), except that the 'shade' contained in each and every macro name has changed to 'shading' in *luamplib*: for instance, while `withshademethod` is a macro name which only works with *metafun* format, the equivalent provided by *luamplib*, `withshadingmethod`, works with *plain* as well. Other differences to the *metafun*'s and some cautions are:

- *Textual pictures* as well as paths can have shading effect. The term *textual picture* means a picture generated by `btex ... etex`, `texttext`, `TEX`, `maketext`, `mplibgraphictext` (see below § 1.2.7), or `infont` operator, though technically only the last one is a true textual picture. Note that the transparency group in which path or text objects are filled without color (see below § 1.2.12 and § 1.2.13) can also be regarded as a textual picture.

```
draw btex \bfseries\TeX etex rotated 20 scaled 6
  withshadingmethod "linear"
  withshadingvector (0,3)
  withshadingstep (
    withshadingfraction 1/2
    withshadingcolors (red,green)
  )
  withshadingstep (
    withshadingfraction 1
    withshadingcolors (green,blue)
  )
;
```



- When shading a picture generated by ‘infont’ operator, the effect of withshadingvector and that of withshadingdirection will be the same, as luamplib considers only the bounding box of the picture.

As shown, the syntax is $\langle path \rangle | \langle textual\ picture \rangle$ withshadingmethod $\langle string \rangle$, where the latter shall be either "linear" or "circular". Other macros for optional values are:

withshadingvector $\langle pair \rangle$ Starting and ending points (as time value) on the path.

withshadingdirection $\langle pair \rangle$ Starting and ending points (as time value) on the bounding box.
Default value: $(0,2)$

withshadingorigin $\langle pair \rangle$ The center of starting and ending circles. Default value: center p, where p is the operand of withshadingmethod.

withshadingradius $\langle pair \rangle$ Radii of starting and ending circles. This is no-op in linear mode.
Default value: $(0, \text{abs}(\text{center } p - \text{urcorner } p))$

withshadingfactor $\langle numeric \rangle$ Multiplier of the radii. This is no-op in linear mode. Default value: 1.2

withshadingcenter $\langle pair \rangle$ Values for shifting starting center. For instance, $(0,0)$ means that the center of starting circle is center p; $(1,1)$ means urcorner p; $(-1,-1)$ means llcorner p.

withshadingtransform $\langle string \rangle$ where $\langle string \rangle$ shall be "yes" (respect transform) or "no" (ignore transform). Default value: "no" for pictures made by infont operator; "yes" for all other cases.

withshadingdomain $\langle pair \rangle$ Limiting values of parametric variable that varies on the axis of color gradient. Default value: $(0,1)$

withshadingstep (...) for combined shading of more than two colors.

withshadingfraction $\langle numeric \rangle$ Fractional number of each shading step. Only meaningful with withshadingstep.

withshadingcolors $(\langle color\ expr \rangle, \langle color\ expr \rangle)$ Starting and ending colors, default value being (white, black). String-type argument is regarded as the color expression of T_EX side.

withshadingstroke $\langle string \rangle$ where $\langle string \rangle$ shall be "yes" or "no". Only meaningful when the shading object is a $\langle path \rangle$; if "yes", we get the path stroked and *then* shaded. More efficient than issueing two sentences.

1.2.6 ... withfademethod ...

This is a METAPOST operator which makes the color of an object gradiently transparent. The syntax is $\langle path \rangle | \langle picture \rangle$ withfademethod $\langle string \rangle$, the latter being either "linear" or "circular". Though it is similar to the withshademethod from *metafun*, the differences are: (1) the operand

of `withfademethod` can be a picture as well as a path; (2) you cannot make gradient colors, but can only make gradient opacity.

Related macros to control optional values are:

`withfadeopacity` ($\langle\text{numeric}\rangle$, $\langle\text{numeric}\rangle$) sets the starting opacity and the ending opacity, default value being (1,0). ‘1’ denotes full color; ‘0’ full transparency.

`withfadevector` ($\langle\text{pair}\rangle$, $\langle\text{pair}\rangle$) sets the starting and ending points. Default value in the linear mode is (llcorner p, lrcorner p), where p is the operand, meaning that fading starts from the left edge and ends at the right edge. Default value in the circular mode is (center p, center p), which means centers of both starting and ending circles are the center of the bounding box.

`withfadecenter` is a synonym of `withfadevector`.

`withfaderadius` ($\langle\text{numeric}\rangle$, $\langle\text{numeric}\rangle$) sets the radii of starting and ending circles. This is no-op in the linear mode. Default value is (0, abs(center p - urcorner p)), meaning that fading starts from the center and ends at the four corners of the bounding box.

`withfadebbox` ($\langle\text{pair}\rangle$, $\langle\text{pair}\rangle$) sets the bounding box of the fading area, default value being (llcorner p, urcorner p). Though this option is not needed in most cases, there could be cases when users want to explicitly control the bounding box. Particularly, see the description [below](#) at § 1.2.12 on the analogous macro `withgroupbbox`.

An example:

```
\mpfig
picture mill;
mill = btex \includegraphics[width=100bp]{mill} etex;
draw mill
  withfademethod "circular"
  withfadecenter (center mill, center mill)
  withfaderadius (20, 50)
  withfadeopacity (1, 0)
;
\endmpfig
```



1.2.7 mplibgraphicstext ...

`mplibgraphicstext` ($\langle\text{string}\rangle$) is a METAPOST operator, the effect of which is similar to that of ConTeXt’s `graphicstext` or our own `mpliboutlinetext` (see below § 1.2.10). However the syntax is somewhat different.

```
draw mplibgraphicstext "\bfseries Funny"
  rotated 20 scaled 3
  fakebold 2.3 % fontspec option
  fillcolor "red!50" % color expression
  drawcolor 2/3 blue % or strokecolor 2/3 blue
;
```

Funny

fakebold, fillcolor and drawcolor (or strokecolor) are optional; default values are 2, "white" and "black" respectively.¹⁰ When the color expression is given in string type, it is regarded as color, xcolor or l3color's expression. All from `mplibgraphicstext` to the end of sentence will compose an anonymous picture, which can be drawn or assigned to a variable. Incidentally, `withfillcolor` and `withdrawcolor` are synonyms of `fillcolor` and `drawcolor`, hopefully to be compatible with `graphicstext`.

N.B. In some cases, especially when processing complicated \TeX code, `mplibgraphicstext` will produce better results than `ConTeXt` or even than our own `mpliboutlinetext`, not to mention the much smaller PDF file size. There are, however, some limitations such that you can't apply shading (gradient colors) to the text with *metafun*'s `withshademethod`.¹¹ Again, in DVI mode, unicode-math package is needed for math formulae, as we cannot embolden type1 fonts in DVI mode. But the most critical limitation is that, unlike `mpliboutlinetext`, you cannot manipulate the shape of outline paths, because the returned picture is basically a `btex ... etex` picture.

1.2.8 `mplibglyph ... of ...`

From v2.30, we provide a new METAPOST operator `mplibglyph`, which returns a METAPOST picture containing outline paths of a glyph in opentype, truetype or type1 fonts. When a type1 font is specified, METAPOST primitive `glyph` will be called.

```
mplibglyph 50 of \fontid\font           % slot 50 of current font
mplibglyph "Q" of "TU/TeXGyrePagella(0)/m/n/10" % font csname
mplibglyph "Q" of "texgyrepagella-regular.otf" % raw filename
mplibglyph "Q" of "Times.ttc(2)" % subfont number
mplibglyph "Q" of "SourceHanSansK-VF.otf[Regular]" % instance name
```

Both arguments before and after "of" can be either a number or a string. Number arguments are regarded as a glyph slot (GID) and a font id number, respectively. String argument at the left side is regarded as a glyph name in the font or a unicode character. String argument at the right side is regarded as a \TeX font csname (without backslash) or the raw filename of a font. When it is a font filename, a number within parentheses after the filename denotes a subfont number (starting from zero) of a TTC font; a string within brackets denotes an instance name of a variable font.

1.2.9 `mplibdrawglyph ...`, `mplibstrokeglyph ...`, `mplibfillandstrokeglyph ...`

As the structure of the picture returned by `mplibglyph` is quite similar to the result of `glyph` primitive, METAPOST's `draw` command will fill the inner path of the picture with the background color. In contrast, `mplibdrawglyph` *<picture>* command fills the paths according to the nonzero winding number rule. As a result, for instance, the area surrounded by inner path of "O" will remain transparent.

N.B. To apply the nonzero winding number rule to a picture containing paths, `luamplib` appends `withpostscript "collect"` to the paths except the last one in the picture. If you want the even-odd rule instead, you can additionally declare `withpostscript "evenodd"` to the last path.

¹⁰Users can use the `withmplibcolors` macro instead of `fillcolor` and `drawcolor` options. See § 1.2.3 on this macro.

¹¹But this limitation is now lifted by the introduction of `withshadingmethod`. See above § 1.2.5.

N.B. By the way, when you want fill-and-stroke effect, issuing `filldraw` command to the last path will not always produce what you want: in such cases, you have to issue the command `draw <the last path> withpostsript "both" (or "eoboth" to apply even-odd rule)`.¹²

As this could be somewhat annoying to users, `luamplib` v2.38.0 or later provides the following commands as well: `mplibfillandstrokeglyph <picture>`, `mplibstrokeglyph <picture>`, and `mplibfillglyph <picture>`, the last one being a synonym of `mplibdrawglyph` command.

An example:

```
mplibfillandstrokeglyph
  mplibglyph "R" of \fontid\font scaled 1/12
  withpen pencircle scaled 1
  withmplibcolors ("orange", 2/3red)
;
```



1.2.10 `mpliboutlinetext (...)`

From v2.31, a new METAPOST operator `mpliboutlinetext` is available, which mimicks *metafun*'s `outlinetext`. So the syntax is the same: see the *metafun* manual § 8.7 (texdoc metafun). A simple example:

```
draw mpliboutlinetext.b ("$\sqrt{2+\alpha}$")
  (withcolor \mpcolor{red!33})
  (withpen pencircle scaled .2 withcolor 2/3red)
  scaled 3
;
```



After the process, `mpliboutlinepic[]` and `mpliboutlinenum` will be preserved as global variables; `mpliboutlinepic[1] ... mpliboutlinepic[mpliboutlinenum]` will be an array of images, each of which containing outline paths of a glyph or a rule.

N.B. As Unicode grapheme cluster is not considered in the array, a unit that must be a single cluster might be separated apart.

1.2.11 `\mppattern{...} ... \endmppattern, ... withmppattern ...`

\TeX macros `\mppattern{<name>} ... \endmppattern` define a tiling pattern cell associated with the *<name>*. METAPOST command `withmppattern`, the syntax being *<cyclic path>* | *<textual picture>* `withmppattern <string>`, will fill the given path or text with the tiling pattern cell of the *<name>* by replicating it horizontally and vertically.¹³ As said before at § 1.2.5, the *textual picture* here means any text typeset by \TeX , mostly the result of the `btex` command (and its derivatives) or the `infont` operator.

¹²*metafun* provides macros `nofill`, `eofill`, `fillup`, `eofillup` etc. (see *metafun* manual § 2.11), which `luamplib` with *plain* format does not provide currently.

¹³`withpattern` is an operator virtually the same as `withmppattern`, but the former forces a METAPOST picture. Therefore you cannot but use `draw` command with `withpattern` operator. On the other hand, if some special command is not appended (see the example just below), *<cyclic path>* `withmppattern <string>` works as intended only with `fill` or `filldraw` command.

Table 1: options for \mppattern

Key	Value Type	Explanation
xstep	<i>number</i>	horizontal spacing between pattern cells
ystep	<i>number</i>	vertical spacing between pattern cells
xshift	<i>number</i>	horizontal shifting of pattern cells
yshift	<i>number</i>	vertical shifting of pattern cells
bbox	<i>table</i> or <i>string</i>	llx, lly, urx, ury values*
matrix	<i>table</i> or <i>string</i>	xx, yx, xy, yy values* or MP transform code
resources	<i>string</i>	PDF resources if needed
colored or coloured	<i>boolean</i>	false for uncolored pattern. default: true

* in string type, numbers are separated by spaces

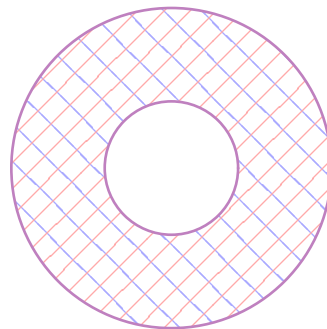
An example:

```

\mppattern{mypatt}           % or \begin{mppattern}{mypatt}
[                             % options: see below
  xstep = 10,
  ystep = 7,
  matrix = "rotated 45",      % or "0.7 0.7 -0.7 0.7" or {0.7, 0.7, -0.7, 0.7}
]
\mpfig                       % or any other TeX code
  draw (up--down) scaled 5
    withcolor 2/3[blue,white]
  ;
  draw (left--right) scaled 5
    withcolor 2/3[red,white]
  ;
\endmpfig
\endmppattern                % or \end{mppattern}

\mpfig
  draw fullcircle scaled 50
    withpostscript "collect"
  ;
  draw fullcircle scaled 120
    withmppattern "mypatt"
    withpen pencircle scaled 1
    withcolor \mpcolor{red!50!blue!50}
    withpostscript "eoboth"
  ;
\endmpfig

```



The available options, actually elements of a Lua *table*, are listed in Table 1. For the sake of convenience, the width and height values of the tiling pattern cell will be written down into the log file (depth is always zero). Users can refer to them for option setting.

As for matrix option, METAPOST code such as "rotated 30 slanted .2" is allowed as well as the string or table of four numbers. You can also set xshift and yshift values by using 'shifted'

operator. But when `xshift` or `yshift` option is explicitly given, they have precedence over the effect of ‘shifted’ operator.

When you use special effect such as transparency in a pattern cell, `resources` option is needed: for instance, `resources="/ExtGState 1 0 R"`. However, as `luamplib` automatically includes the resources of the current page, this option is not needed in most cases.

Option `colored=false` (or `coloured=false`) will generate an uncolored pattern cell which shall have no color at all (i.e. `withoutcolor` command is needed for the cells made from `METAPOST` code). Uncolored pattern will be painted later by the color of a `METAPOST` object. An example:

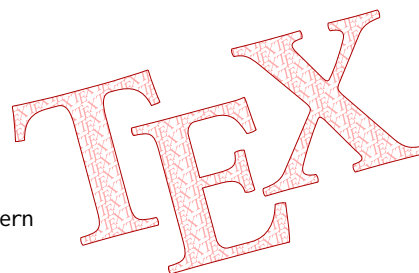
```
\begin{mppattern}{pattnocolor}
[
  colored = false,
  matrix = "slanted .3 rotated 30",
]
\tiny\TeX
\end{mppattern}

\begin{mplibcode}
beginfig(1)
picture tex;
tex = mpliboutlinetext.p ("bfseries \TeX");
for i=1 upto mpliboutlinenum:
  mplibfillandstrokeglyph mpliboutlinepic[i]
    scaled 8
    withmppattern "pattnocolor"
    withpen pencircle scaled 1/2
    withcolor (i/4)[red,blue]      % paints the pattern
;
endfor
endfig;
\end{mplibcode}
```



A much simpler and efficient way to obtain a similar result (but without colorful characters in this example) is to give a *textual picture* as the operand of `withmppattern`:

```
\begin{mplibcode}
beginfig(2)
draw mplibgraphictext "bfseries\TeX"
  fakebold 1/2
  rotated 15 scaled 8
  withmppattern "pattnocolor"
  withmplibcolors (
    2/3[red,white],      % paints the pattern
    2/3 red
  )
;
endfig;
\end{mplibcode}
```



1.2.12 ... asgroup ...

As said [before](#), transparency group is available with *plain* as well as *metafun* format. The syntax is exactly the same: $\langle picture \rangle | \langle path \rangle$ asgroup "" | "isolated" | "knockout" | "isolated,knockout", which will return a METAPOST picture. It is called *Transparency Group* because the objects contained in the group are composited to produce a single object, so that outer transparency effect, if any, will be applied to the group as a whole, not to the individual objects cumulatively.

The additional feature provided by *luamplib* is that you can reuse the group as many times as you want in the T_EX code or in other METAPOST code chunks, with infinitesimal increase in the size of PDF file. For this functionality we provide T_EX and METAPOST macros as follows:

`withgroupname $\langle string \rangle$` associates a transparency group with the given name. When this is not appended to the sentence with `asgroup` operator, the default group name 'lastmplibgroup' will be used.

`\usemplibgroup{ $\langle name \rangle$ }` is a T_EX command to reuse a transparency group of the name once used. Note that the position of the group will be origin-based: in other words, lower-left corner of the bounding box will be shifted to the origin.

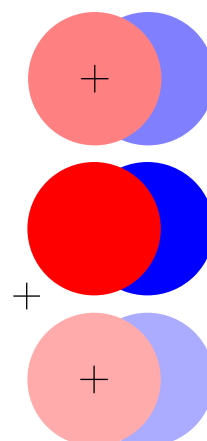
`usemplibgroup $\langle string \rangle$` is a METAPOST command which will add a transparency group of the name to the currentpicture. Contrary to the T_EX command just mentioned, the position of the group is the same as the original transparency group.

`withgroupbbox ($\langle pair \rangle$, $\langle pair \rangle$)` sets the bounding box of the transparency group, default value being (llcorner p, urcorner p). This option might be needed especially when you draw with a thick pen a path that touches the boundary; you would probably want to append to the sentence 'withgroupbbox (bot lft llcorner p, top rt urcorner p)', supposing that the pen was selected by the `pickup` command.

An example showing the difference between the T_EX and METAPOST commands:

```
\mpfig
draw image(
  fill fullcircle scaled 50 shifted 20right withcolor blue;
  fill fullcircle scaled 50 withcolor red ;
)
asgroup ""
withgroupname "mygroup"
withtransparency (1, 1/2)
;
draw (left--right) scaled 5;
draw (up--down) scaled 5;
\endmpfig

\noindent
\clap{\vrule width 10bp height .25bp depth .25bp}%
\clap{\vrule width .5bp height 5bp depth 5bp}%
\usemplibgroup{mygroup}
```



```

\mpfig
  usemplibgroup "mygroup"
    withtransparency (1, 1/3)
  ;
  draw (left--right) scaled 5;
  draw (up--down) scaled 5;
\endmpfig

```

Also note that normally the transparency groups are not affected by outer color commands. However, if you have made the original transparency group using `withoutcolor` command, colors will have effects on the uncolored objects in the group.

1.2.13 `\mplibgroup{...} ... \endmplibgroup`

These \TeX macros are described here in this subsection, as they are deeply related to the `asgroup` operator. Users can define a transparency group or a normal *form XObject* with these macros from \TeX side. The syntax is similar to the `\mppattern` command (see above § 1.2.11).

An example:

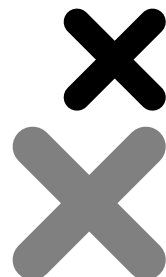
```

\mplibgroup{mygrx}           % or \begin{mplibgroup}{mygrx}
[                             % options: see below
  asgroup="",
]
\mpfig                       % or any other TeX code
  pickup pencircle scaled 10;
  draw (left--right) scaled 20 rotated 45 ;
  draw (left--right) scaled 20 rotated -45 ;
\endmpfig
\endmplibgroup               % or \end{mplibgroup}

\usemplibgroup{mygrx}

\mpfig
  usemplibgroup "mygrx" scaled 1.5
    withtransparency (1, 0.5)
  ;
\endmpfig

```



Available options, much fewer than those for `\mppattern`, are listed in Table 2. Again, the width/height/depth values of the `mplibgroup` will be written down into the log file.

When `asgroup` option, including empty string, is not given, a normal *form XObject* will be generated rather than a transparency group. Thus the individual objects, not the *XObject* as a whole, will be affected by outer transparency command.

As shown, you can reuse the `mplibgroup` using the \TeX command `\usemplibgroup` or the `METAPOST` command `usemplibgroup`. The behavior of these commands is the same as that described above at § 1.2.12, excepting that the `mplibgroup` made by \TeX code (not by `METAPOST` code) respects original height and depth.

Table 2: options for \mplibgroup

Key	Value Type	Explanation
asgroup	<i>string</i>	"" , "isolated" , "knockout" , or "isolated,knockout"
bbox	<i>table</i> or <i>string</i>	llx, lly, urx, ury values*
matrix	<i>table</i> or <i>string</i>	xx, yx, xy, yy values* or MP transform code
resources	<i>string</i>	PDF resources if needed

* in string type, numbers are separated by spaces

1.2.14 mpliblength ..., mplibuclength ...

`mpliblength` $\langle string \rangle$ returns the number of unicode characters in the string. This is a unicode-aware version equivalent to the METAPOST primitive `length`, but accepts only a string-type argument. For instance, `mpliblength "abçdéf"` returns 6, not 8.

On the other hand, `mplibuclength` $\langle string \rangle$ returns the number of unicode grapheme clusters in the string. For instance, `mplibuclength "Äpfel"`, where Ä is encoded using two codepoints (U+0041 and U+0308), returns 5, not 6 or 7. This operator requires lua-uni-algos package.

1.2.15 mplibsubstring ... of ..., mplibucsubstring ... of ...

`mplibsubstring` $\langle pair \rangle$ of $\langle string \rangle$ is a unicode-aware version equivalent to the METAPOST's `substring ... of ...` primitive. The syntax is the same as the latter, but the string is indexed by unicode characters. For instance, `mplibsubstring (2,5) of "abçdéf"` returns "çdé", and `mplibsubstring (5,2) of "abçdéf"` returns "édç".

On the other hand, `mplibucsubstring` $\langle pair \rangle$ of $\langle string \rangle$ returns the part of the string indexed by unicode grapheme clusters. For instance, `mplibucsubstring (0,1) of "Äpfel"`, where Ä is encoded using two codepoints (U+0041 and U+0308), returns "Ä", not "A". This operator requires lua-uni-algos package.

1.3 Lua

1.3.1 runscript ...

A good many METAPOST macros described in this documentation have been implemented using the primitive `runscript`. With `runscript` $\langle string \rangle$, you can run a Lua code chunk from METAPOST side and get some METAPOST code returned by Lua if you want. As the functionality is provided by the `mplib` library itself, `luamplib` does not have much to say about it.

One thing is worth mentioning, however: if you return a Lua *table* to the METAPOST process, it is automatically converted to a relevant METAPOST data type such as `pair`, `color`, `cmykcolor` or `transform`. So users can save some extra toil of converting a table to a string, though it's not a big deal. For instance, `runscript "return {1,0,0}"` will give you the METAPOST color expression `(1,0,0)` automatically.

1.3.2 Lua table `luamplib.instances`

Users can access the Lua table containing `mplib` instances, `luamplib.instances`, through which `METAPOST` variables are also easily accessible from Lua side, as documented in `LuaTeX` manual § 11.2.8.4 (texdoc `luatex`). The following example will print `false`, `3.0`, `MetaPost` and the knots and the cyclicity of the path `unitsquare`.

```
\begin{mplibcode}[myinstance]
  boolean b; b = 1 > 2;
  numeric n; n = 3;
  string s; s = "MetaPost";
  path p; p = unitsquare;
\end{mplibcode}

\directlua{
  local myinstance = luamplib.instances.myinstance
  print( myinstance:get_boolean "b" )
  print( myinstance:get_numeric "n" )
  print( myinstance:get_string "s" )
  local t = myinstance:get_path "p"
  for k,v in pairs(t) do
    print(k, type(v)=='table' and table.concat(v, ' ') or v)
  end
}
```

Of course, this sort of Lua code can also be run inside `METAPOST` code using `runscript` command. Again, of course you can access a `METAPOST` variable using your own `TeX` macro. For example:

```
\def\mpnumeric#1#2{\directlua{
  tex.sprint(tostring(luamplib.instances["#1"]:get_numeric"#2"))
}}
\mpnumeric{myinstance}{n}\relax
```

3.0

1.3.3 Lua function `luamplib.process_mplibcode`

Users can run a `METAPOST` code chunk from Lua side by using this function:

```
luamplib.process_mplibcode (<string> metapost code, <string> instance name)
```

The second argument cannot be absent, but can be an empty string (`""`) which means that it has no instance name.

Some other elements in the `luamplib` namespace, listed in Table 3, can affect the process of `process_mplibcode`.

1.3.4 Lua function `luamplib.registerpattern`

This is the Lua interface for `\mppattern ... \endmppattern` described above at § 1.2.11.

```
luamplib.registerpattern (<number> box register, <string> pattern name, <table> options)
```

Table 3: elements in luamplib table (partial)

Key	Type	Related T _E X macro	Cf.
codeinherit	<i>boolean</i>	<code>\mplibcodeinherit</code>	§ 1.1.8
everyendmplib	<i>table</i>	<code>\everyendmplib</code>	§ 1.1.2
everymplib	<i>table</i>	<code>\everymplib</code>	§ 1.1.2
getcachedir	<i>function</i> ($\langle string \rangle$)	<code>\mplibcachedir</code>	§ 1.1.15
globaltexttext	<i>boolean</i>	<code>\mplibglobaltexttext</code>	§ 1.1.9
legacyverbatimtex	<i>boolean</i>	<code>\mpliblegacybehavior</code>	§ 1.1.6
noneedtoreplace	<i>table</i>	<code>\mplibmakenocache</code>	§ 1.1.15
numbersystem	<i>string</i>	<code>\mplibnumbersystem</code>	§ 1.1.4
setformat	<i>function</i> ($\langle string \rangle$)	<code>\mplibsetformat</code>	§ 1.1.3
showlog	<i>boolean</i>	<code>\mplibshowlog</code>	§ 1.1.5
texttextlabel	<i>boolean</i>	<code>\mplibtexttextlabel</code>	§ 1.1.7
verbatiminput	<i>boolean</i>	<code>\mplibverbatim</code>	§ 1.1.11

The first argument is the register of a box containing a pattern cell, which should be prepared in advance by the user. For instance, `\setbox0=\hbox{\tiny\TeX}`, or corresponding Lua code using `tex.setbox` function; then the argument should be \emptyset .

As for the third argument, see above Table 1. The argument cannot be absent, but can be an empty table, i.e. `{ }`.

1.3.5 Lua function `luamplib.registergroup`

This is the Lua interface for `\mplibgroup ... \endmplibgroup` described above at § 1.2.13.

`luamplib.registergroup` ($\langle number \rangle$ box register, $\langle string \rangle$ group name, $\langle table \rangle$ options)

The first argument is the register of a box prepared in advance by the user. When the contents of the box have been generated from T_EX (not METAPOST) code, please make sure that both of the T_EX macros ‘`MPllx`’ and ‘`MPlly`’ are defined as ‘ \emptyset ’ before invoking the Lua function.

As for the third argument, see above Table 2. The argument cannot be absent, but can be an empty table, i.e. `{ }`.

Reusing an `mplibgroup`, `\usemplibgroup{\langle name \rangle}`, is basically the same as running the T_EX macro ‘`luamplib.group.\langle name \rangle`’. If you need the `boxresource` index, inspect this macro using `token.get_macro` function.

2 Implementation

2.1 Lua module

```

1
2 luatexbase.provides_module {
3   name      = "luamplib",
4   version   = "2.38.4",

```

```

5  date          = "2026/01/29",
6  description   = "Lua package to typeset Metapost with LuaTeX's MPLib.",
7 }
8

```

Use the `luamplib` namespace, since `mplib` is for the `METAPOST` library itself. Con_TE_Xt uses `metapost`.

```

9 luamplib      = luamplib or { }
10 local luamplib = luamplib
11
12 local format, abs = string.format, math.abs
13
14 Use our own function for warn/info/err.
15 local function termorlog (target, text, kind)
16   if text then
17     local mod, write, append = "luamplib", texio.write_nl, texio.write
18     kind = kind
19     or target == "term" and "Warning (more info in the log)"
20     or target == "log" and "Info"
21     or target == "term and log" and "Warning"
22     or "Error"
23     target = kind == "Error" and "term and log" or target
24     local t = text:explode"\n+"
25     write(target, format("Module %s %s:", mod, kind))
26     if #t == 1 then
27       append(target, format(" %s", t[1]))
28     else
29       for _,line in ipairs(t) do
30         write(target, line)
31       end
32       write(target, format("(%s) ", mod))
33     end
34     append(target, format(" on input line %s", tex.inputlineno))
35     write(target, "")
36     if kind == "Error" then error() end
37   end
38 end
39 local function warn (...) -- beware '%' symbol
40   termorlog("term and log", select("#",...) > 1 and format(...) or ...)
41 end
42 local function info (...)
43   termorlog("log", select("#",...) > 1 and format(...) or ...)
44 end
45 local function err (...)
46   termorlog("error", select("#",...) > 1 and format(...) or ...)
47 end
48 luamplib.showlog = luamplib.showlog or false
49

```


Provide a few “shortcuts” expected by the code.

```
50 local tableconcat = table.concat
51 local tableinsert = table.insert
52 local tableunpack = table.unpack
53 local texsprint   = tex.sprint
54 local texgettoks  = tex.gettoks
55 local texgetbox   = tex.getbox
56 local texruntoks  = tex.runtoks
57 if not texruntoks then
58   err("Your LuaTeX version is too old. Please upgrade it to the latest")
59 end
60 local is_defined = token.is_defined
61 local get_macro  = token.get_macro
62 local mplib = require('mplib')
63 local kpse = require('kpse')
64 local lfs = require('lfs')
65 local lfsattributes = lfs.attributes
66 local lfsisdir      = lfs.isdir
67 local lfsmkdir      = lfs.mkdir
68 local lfstouch      = lfs.touch
69 local iioopen       = io.open
70
```

Some helper functions, prepared for the case when l-file etc is not loaded.

```
71 local file = file or { }
72 local replacesuffix = file.replacesuffix or function(filename, suffix)
73   return (filename:gsub("%.[%a%d]+$", "")) .. "." .. suffix
74 end
75 local is_writable = file.is_writable or function(name)
76   if lfsisdir(name) then
77     name = name .. "/_luam_plib_temp_file_"
78     local fh = iioopen(name, "w")
79     if fh then
80       fh:close(); os.remove(name)
81       return true
82     end
83   end
84 end
85 local mk_full_path = lfs.mkdirp or lfs.mkdirs or function(path)
86   local full = ""
87   for sub in path:gmatch("(/*[^\n/]+)") do
88     full = full .. sub
89     lfsmkdir(full)
90   end
91 end
92
```

btex ... etex in input .mp files will be replaced in finder. Because of the limitation of mplib regarding make_text, we might have to make cache files modified from input files.

First of all, determine the directory to store cache files.

```

93 local outputdir, cachedir
94 if lfstouch then
95   for i,v in ipairs{'TEXMFVAR','TEXMF_OUTPUT_DIRECTORY','.', 'TEXMFOUTPUT'} do
96     local var = i == 3 and v or kpse.var_value(v)
97     if var and var ~= "" then
98       for _,vv in next, var:explode(os.type == "unix" and ":" or ";") do
99         local dir = format("%s/%s",vv,"luamplib_cache")
100         if not lfsisdir(dir) then
101           mk_full_path(dir)
102         end
103         if is_writable(dir) then
104           outputdir = dir
105           break
106         end
107       end
108       if outputdir then break end
109     end
110   end
111 end
112 outputdir = outputdir or '.'
113 function luamplib.getcachedir(dir)
114   dir = dir:gsub("##", "#")
115   dir = dir:gsub("^~",
116     os.type == "windows" and os.getenv("UserProfile") or os.getenv("HOME"))
117   if lfstouch and dir then
118     if lfsisdir(dir) then
119       if is_writable(dir) then
120         cachedir = dir
121       else
122         warn("Directory '%s' is not writable!", dir)
123       end
124     else
125       warn("Directory '%s' does not exist!", dir)
126     end
127   end
128 end

```

Some basic METAPOST files not necessary to make cache files.

```

129 local noneedtoreplace = {
130   ["boxes.mp"] = true, -- ["format.mp"] = true,
131   ["graph.mp"] = true, ["marith.mp"] = true, ["mfplain.mp"] = true,
132   ["mpost.mp"] = true, ["plain.mp"] = true, ["rboxes.mp"] = true,
133   ["sarith.mp"] = true, ["string.mp"] = true, -- ["TEX.mp"] = true,
134   ["metafun.mp"] = true, ["metafun.mpiv"] = true, ["mp-abck.mpiv"] = true,
135   ["mp-apos.mpiv"] = true, ["mp-asnc.mpiv"] = true, ["mp-bare.mpiv"] = true,
136   ["mp-base.mpiv"] = true, ["mp-blob.mpiv"] = true, ["mp-butt.mpiv"] = true,
137   ["mp-char.mpiv"] = true, ["mp-chem.mpiv"] = true, ["mp-core.mpiv"] = true,
138   ["mp-crop.mpiv"] = true, ["mp-figs.mpiv"] = true, ["mp-form.mpiv"] = true,
139   ["mp-func.mpiv"] = true, ["mp-grap.mpiv"] = true, ["mp-grid.mpiv"] = true,
140   ["mp-grph.mpiv"] = true, ["mp-idea.mpiv"] = true, ["mp-luas.mpiv"] = true,

```

```

141 ["mp-mlib.mpiv"] = true, ["mp-node.mpiv"] = true, ["mp-page.mpiv"] = true,
142 ["mp-shap.mpiv"] = true, ["mp-step.mpiv"] = true, ["mp-text.mpiv"] = true,
143 ["mp-tool.mpiv"] = true, ["mp-cont.mpiv"] = true,
144 }
145 luamplib.noneedtoreplace = noneedtoreplace
146

```

Pattern formats to replace btex and verbatimex ... etex in input files, if needed.

```

147 local name_b = "%f[%a_]"
148 local name_e = "%f[^%a_]"
149 local btex_etex = name_b.."btex"..name_e.."%s*(.)%s*"..name_b.."etex"..name_e
150 local verbatimex_etex = name_b.."verbatimex"..name_e.."%s*(.)%s*"..name_b.."etex"..name_e
151

```

Function luamplib.finder

```

152 local currenttime = os.time()
153 do
154   local luamplibtime = lfsattributes(kpse.find_file"luamplib.lua", "modification")

```

format.mp is much complicated, so specially treated.

```

155   local function replaceformatmp(file,newfile,ofmodify)
156     local fh = ioopen(file,"r")
157     if not fh then return file end
158     local data = fh:read("*all"); fh:close()
159     fh = ioopen(newfile,"w")
160     if not fh then return file end
161     fh:write(
162       "let normalinfont = infont;\n",
163       "primarydef str infont name = rawtexttext(str) enddef;\n",
164       data,
165       "vardef Fmant_(expr x) = rawtexttext(decimal abs x) enddef;\n",
166       "vardef Fexp_(expr x) = rawtexttext("\$^{\"&decimal x&\"}\$") enddef;\n",
167       "let infont = normalinfont;\n"
168     ); fh:close()
169     lfstouch(newfile,currenttime,ofmodify)
170     return newfile
171   end
172   local function replaceinputmpfile (name,file)
173     local ofmodify = lfsattributes(file,"modification")
174     if not ofmodify then return file end
175     local newfile = name:gsub("%W","_")
176     newfile = format("%s/luamplib_input_%s", cachedir or outputdir, newfile)
177     if newfile and luamplibtime then
178       local nf = lfsattributes(newfile)
179       if nf and nf.mode == "file" and
180         ofmodify == nf.modification and luamplibtime < nf.access then
181         return nf.size == 0 and file or newfile
182       end
183     end
184     if name == "format.mp" then return replaceformatmp(file,newfile,ofmodify) end
185     local fh = ioopen(file,"r")

```

```

186     if not fh then return file end
187     local data = fh:read("*all"); fh:close()

```

“etex” must be preceded by a space and followed by a space or semicolon as specified in Lua \TeX manual, which is not the case of standalone METAPOST though.

```

188     local count,cnt = 0,0
189     data, cnt = data:gsub(btex_etex, "btex %1 etex ") -- space
190     count = count + cnt
191     data, cnt = data:gsub(verbatim_etex, "verbatim %1 etex;") -- semicolon
192     count = count + cnt
193     if count == 0 then
194         needtoreplace[name] = true
195         fh = ioopen(newfile,"w");
196         if fh then
197             fh:close()
198             lfstouch(newfile,currenttime,ofmodify)
199         end
200         return file
201     end
202     fh = ioopen(newfile,"w")
203     if not fh then return file end
204     fh:write(data); fh:close()
205     lfstouch(newfile,currenttime,ofmodify)
206     return newfile
207 end

```

As the finder function for mplib, use the kpse library and make it behave like as if METAPOST was used. And replace .mp files with cache files if needed. See also #74, #97.

```

208 local mpkpse
209 do
210     local exe = 0
211     while arg[exe-1] do
212         exe = exe-1
213     end
214     mpkpse = kpse.new(arg[exe], "mpost")
215 end
216 local special_ftype = {
217     pfb = "type1 fonts",
218     enc = "enc files",
219 }
220 function luamplib.finder (name, mode, ftype)
221     if mode == "w" then
222         if name and name ~= "mpout.log" then
223             kpse.record_output_file(name) -- recorder
224         end
225         return name
226     else
227         ftype = special_ftype[ftype] or ftype
228         local file = mpkpse.find_file(name,ftype)
229         if file then

```

```

230     if lfstouch and ftype == "mp" and not noneedtoreplace[name] then
231         file = replaceinputmpfile(name, file)
232     end
233 else
234     file = mpkpse:find_file(name, name:match("%a+$"))
235 end
236 if file then
237     kpse.record_input_file(file) -- recorder
238 end
239 return file
240 end
241 end
242 end
243

```

For the main function: process

plain or *metafun*, though we cannot support *metafun* format fully.

```

244 local currentformat = "plain"
245 function luamplib.setformat (name)
246     currentformat = name
247 end

```

v2.9 has introduced the concept of “code inherit”

```

248 luamplib.codeinherit = false
249 local mplibinstances = {}
250 luamplib.instances = mplibinstances
251 local has_instancename = false
252
253 local process
254 do
255     local function reporterror (result, prevlog)
256         if not result then
257             err("no result object returned")
258         else
259             local t, e, l = result.term, result.error, result.log

```

log has more information than term, so log first (2021/08/02)

```

260     local log = l or t or "no-term"
261     log = log:gsub("%(Please type a command or say `end'%)", ""):gsub("\n+", "\n")
262     if result.status > 0 then
263         local first = log:match"(.-\n! .-)\n! "
264         if first then
265             termorlog("term", first)
266             termorlog("log", log, "Warning")
267         else
268             warn(log)
269         end
270         if result.status > 1 then
271             err(e or "see above messages")
272         end
273     elseif prevlog then

```

```
274     log = prevlog..log
```

v2.6.1: now `luamplib` does not disregard `show` command, even when `luamplib.showlog` is false. Incidentally, it does not raise error nor prints an info, even if output has no figure.

```
275     local show = log:match"\n>>? .+"
276     if show then
277         termorlog("term", show, "Info (more info in the log)")
278         info(log)
279     elseif luamplib.showlog and log:find"%g" then
280         info(log)
281     end
282 end
283 return log
284 end
285 end
```

`lualibs-os.lua` installs a randomseed. When this file is not loaded, we should explicitly seed a unique integer to get random randomseed for each run.

```
286 if not math.initialseed then math.randomseed(currenttime) end
287 local function luamplibload (name)
288     local mpx = mplib.new {
289         ini_version = true,
290         find_file   = luamplib.finder,
```

Make use of `make_text` and `run_script`. And we provide `numbersystem` option since v2.4. See <https://github.com/lualatex/luamplib/issues/21>.

```
291     make_text   = luamplib.maketext,
292     run_script  = luamplib.runscript,
293     math_mode   = luamplib.numbersystem,
294     job_name     = tex.jobname,
295     random_seed = math.random(4095),
296     utf8_mode   = true,
297     extensions  = 1,
298 }
```

Append our own `METAPOST` preamble to the preamble loading plain/metafun format.

```
299 local preamble = tableconcat{
300     format(luamplib.preambles.preamble, replacesuffix(name,"mp")),
301     luamplib.preambles.mplibcode,
302     luamplib.legacyverbatim and luamplib.preambles.legacyverbatim or "",
303     luamplib.texttextlabel and luamplib.preambles.texttextlabel or "",
304 }
305 local result, log
306 if not mpx then
307     result = { status = 99, error = "out of memory"}
308 else
309     result = mpx:execute(preamble)
310 end
311 log = reporterror(result)
312 return mpx, result, log
313 end
```

Here, excute each mplibcode data, ie `\begin{mplibcode} ... \end{mplibcode}`.

```

314 function process (data, instancename)
315   local currfmt
316   if instancename and instancename ~= "" then
317     currfmt = instancename
318     has_instancename = true
319   else
320     currfmt = tableconcat{
321       currentformat,
322       luamplib.numbersystem or "scaled",
323       tostring(luamplib.texttextlabel),
324       tostring(luamplib.legacyverbatimtex),
325     }
326     has_instancename = false
327   end
328   local mpx = mplibinstances[currfmt]
329   local standalone = not (has_instancename or luamplib.codeinherit)
330   if mpx and standalone then
331     mpx:finish()
332   end
333   local log = ""
334   if standalone or not mpx then
335     mpx, _, log = luamplibload(currentformat)
336     mplibinstances[currfmt] = mpx
337   end
338   local converted, result = false, {}
339   if mpx and data then
340     result = mpx:execute(data)
341     local log = reporterror(result, log)
342     if log then
343       if result.fig then
344         converted = luamplib.convert(result)
345       end
346     end
347   else
348     err"Mem file unloadable. Maybe generated with a different version of mplib?"
349   end
350   return converted, result
351 end
352 end
353

```

`dvipdfmx` is supported, though nobody seems to use it.

```

354 local pdfmode = tex.outputmode > 0
355

```

`make_text` and some `run_script` uses Lua_T_EX's `tex.runtoks`.

```

356 local catlatex = luatexbase.registernumber("catcodetable@latex")
357 local catat11 = luatexbase.registernumber("catcodetable@atletter")

```

`tex.scantoks` sometimes fail to read catcode properly, especially `\#`, `\&`, or `\%`. After some exper-

iment, we dropped using it. Instead, a function containing `tex.sprint` seems to work nicely.

```

358 local function run_tex_code (str, cat)
359   texruntoks(function() texsprint(cat or catlatex, str) end)
360 end

```

For conversion of sp to bp.

```

361 local factor = 65536*(7227/7200)
362

```

Prepare texttext box number containers, locals and globals. `localid` can be any number. They are local anyway. The number will be reset at the start of a new code chunk. Global boxes will use `\newbox` command in `tex.runtoks` process. This is the same when `codeinherit` is true. Boxes in instances with name will also be global, so that their tex boxes can be shared among instances of the same name.

```

363 local texboxes = { globalid = 0, localid = 4096 }
364 local process_tex_text
365 do
366   local texttext_fmt = 'image(addto currentpicture doublepath unitsquare \z
367     xscaled %f yscaled %f shifted (0,-%f) \z
368     withprescript "mplibtexboxid=%i:%f:%f")'
369   function process_tex_text (str, maketext)
370     if str then
371       if not maketext then str = str:gsub("\r.-$", "") end
372       local global = (has_instancename or luamplib.globaltexttext or luamplib.codeinherit)
373         and "\global" or ""
374       local tex_box_id
375       if global == "" then
376         tex_box_id = texboxes.localid + 1
377         texboxes.localid = tex_box_id
378       else
379         local boxid = texboxes.globalid + 1
380         texboxes.globalid = boxid
381         run_tex_code(format([[expandafter\newbox\csname luamplib.box.%s\endcsname]], boxid))
382         tex_box_id = tex.getcount'allocationnumber'
383       end
384       if str:find"^[taggingoff%]" then
385         str = str:gsub("^[taggingoff%]*s*", "")
386         run_tex_code(format("\luamplibnotagtextboxset{%i}{%s\\setbox%i\\hbox{%s}}",
387           tex_box_id, global, tex_box_id, str))
388       else
389         run_tex_code(format("\luamplibtagtextboxset{%i}{%s\\setbox%i\\hbox{%s}}",
390           tex_box_id, global, tex_box_id, str))
391       end
392       local box = texgetbox(tex_box_id)
393       local wd = box.width / factor
394       local ht = box.height / factor
395       local dp = box.depth / factor
396       return texttext_fmt:format(wd, ht+dp, dp, tex_box_id, wd, ht+dp)
397     end
398   return ""

```



```

399 end
400 end
401

```

Make color or xcolor's color expressions usable, with \mpcolor or mplibcolor. These commands should be used with graphical objects. Attempt to support l3color as well.

```

402 if is_defined'color_select:n' then
403   run_tex_code{
404     "\newcatcodetable\luamplibcctabexplat",
405     "\begingroup",
406     "\catcode\@=11 ",
407     "\catcode\_ =11 ",
408     "\catcode\:=11 ",
409     "\savecatcodetable\luamplibcctabexplat",
410     "\endgroup",
411   }
412 end
413 local ccexplat = luatexbase.registernumber"luamplibcctabexplat"
414
415 local process_color, process_mplibcolor

```

A common function for color functions

```

416 local function colorsplit (res)
417   local t, tt = { }, res:gsub("[%%]", "", 2):explode()
418   local be = tt[1]:find"^%d" and 1 or 2
419   for i=be, #tt do
420     if not tonumber(tt[i]) then break end
421     t[#t+1] = tt[i]
422   end
423   if #t == 0 then -- named color in DVI mode with no DocumentMetadata
424     run_tex_code{"\extractcolorspecs", tt[3], "\mplibtmpa\mplibtmpb"}
425     t = get_macro"mplibtmpb":explode",
426   end
427   return t
428 end
429 do
430   local colfmt = ccexplat and "l3color" or "xcolor"
431   local mplibcolorfmt = {
432     xcolor = tableconcat{
433       [[\begingroup\let\XC@mcolor\relax]],
434       [[\def\set@color{\global\mplibtmp toks\expandafter{\current@color}}]],
435       [[\color%s\endgroup]],
436     },
437     l3color = tableconcat{
438       [[\begingroup\def\__color_select:N#1{\expandafter\__color_select:nn#1}]],
439       [[\def\__color_backend_select:nn#1#2{\global\mplibtmp toks{#1 #2}}]],
440       [[\def\__kernel_backend_literal:e#1{\global\mplibtmp toks\expandafter{\expanded{#1}}}],
441       [[\color_select:n%s\endgroup]],
442     },
443   }

```

```

444 function process_color (str)
445   if str then
446     if not str:find("%b{") then
447       str = format("{%s}",str)
448     end
449     local myfmt = mplibcolorfmt[colfmt]
450     if colfmt == "l3color" and is_defined"color" then
451       if str:find("%b[") then
452         myfmt = mplibcolorfmt.xcolor
453       else
454         for _,v in ipairs(str:match"{(.+)}":explode"!") do
455           if not v:find("^%s*d+%s*$") then
456             local pp = get_macro(format("l__color_named_%s_prop",v))
457             if not pp or pp == "" then
458               myfmt = mplibcolorfmt.xcolor
459             break
460           end
461         end
462       end
463     end
464   end
465   run_tex_code(myfmt:format(str), ccexplat or catat11)
466   local t = texgettoks"mplibtmptoks"
467   if not pdfmode then
468     if t:find"^hsb" or not t:find"%d" then
469       t = "color push " .. t
470     elseif not t:find"pdf" then
471       t = t:gsub("%a+ (.+)", "pdf:bc [%1]")
472     end
473   end
474   return format('1 withprescript "mpliboverridecolor=%s"', t)
475 end
476 return ""
477 end
478 function process_mplibcolor(str)
479   local res = process_color(str)
480   if res:find"cs " or res:find"@pdf.obj" or res:find"color push" then return res end
481   res = colorsplit(res:match'"mpliboverridecolor=(.)"')
482   return format("(%s)", tableconcat(res, ","))
483 end
484 end
485
486 for \mpdim or mplibdimen
487 local function process_dimen (str)
488   if str then
489     str = str:gsub("{(.+)}", "%1")
490     run_tex_code(format([[ \mplibtmptoks\expandafter{\the\dimexpr %s\relax}]], str))
491     return format("begingroup %s endgroup", texgettoks"mplibtmptoks")
492   end

```

```

492 return ""
493 end
494

```

Newly introduced method of processing verbatimtex ... etex. This function is used when \mpliblegacybehavior{false} is declared.

```

495 local function process_verbatimtex_text (str)
496   if str then
497     run_tex_code(str)
498   end
499   return ""
500 end
501

```

For legacy verbatimtex process. verbatimtex ... etex before beginfig() is inserted just before the mplib box. And T_EX code inside beginfig() ... endfig is inserted after the mplib box.

```

502 local tex_code_pre_mplib = {}
503 luamplib.figid = 1
504 luamplib.in_the_fig = false
505 local function process_verbatimtex_prefig (str)
506   if str then
507     tex_code_pre_mplib[luamplib.figid] = str
508   end
509   return ""
510 end
511 local function process_verbatimtex_infig (str)
512   if str then
513     return format('special "postmplibverbtex=%s";', str)
514   end
515   return ""
516 end
517

```

For *metafun* format. see issue #79.

```

518 mp = mp or {}
519 local mp = mp
520 mp.mf_path_reset = mp.mf_path_reset or function() end
521 mp.mf_finish_saving_data = mp.mf_finish_saving_data or function() end
522 mp.report = mp.report or info

```

metafun 2021-03-09 changes crashes luamplib.

```

523 catcodes = catcodes or {}
524 local catcodes = catcodes
525 catcodes.numbers = catcodes.numbers or {}
526 catcodes.numbers.ctxcatcodes = catcodes.numbers.ctxcatcodes or catlatex
527 catcodes.numbers.texcatcodes = catcodes.numbers.texcatcodes or catlatex
528 catcodes.numbers.luacatcodes = catcodes.numbers.luacatcodes or catlatex
529 catcodes.numbers.notcatcodes = catcodes.numbers.notcatcodes or catlatex
530 catcodes.numbers.vrbcatcodes = catcodes.numbers.vrbcatcodes or catlatex
531 catcodes.numbers.prtcatcodes = catcodes.numbers.prtcatcodes or catlatex
532 catcodes.numbers.txtcatcodes = catcodes.numbers.txtcatcodes or catlatex

```

533

Now `luamplib.runscript`

```
534 do
535   local runscript_funcs = {
536     luamplibtext    = process_tex_text,
537     luamplibcolor   = process_mplibcolor,
538     luamplibdimen    = process_dimen,
539     luamplibprefig   = process_verbatimtex_prefig,
540     luamplibinfig    = process_verbatimtex_infig,
541     luamplibverbtex  = process_verbatimtex_text,
542   }
```

A function from ConT_EXt general.

```
543   local function mpprint(buffer,...)
544     for i=1,select("#",...) do
545       local value = select(i,...)
546       if value ~= nil then
547         local t = type(value)
548         if t == "number" then
549           buffer[#buffer+1] = format("%.16f",value)
550         elseif t == "string" then
551           buffer[#buffer+1] = value
552         elseif t == "table" then
553           buffer[#buffer+1] = "(" .. tableconcat(value,",") .. ")"
554         else -- boolean or whatever
555           buffer[#buffer+1] = tostring(value)
556         end
557       end
558     end
559   end
560   function luamplib.runscript (code)
561     local id, str = code:match("(.-){(.*)}")
562     if id and str then
563       local f = runscript_funcs[id]
564       if f then
565         local t = f(str)
566         if t then return t end
567       end
568     end
569     local f = loadstring(code)
570     if type(f) == "function" then
571       local buffer = {}
572       function mp.print(...)
573         mpprint(buffer,...)
574       end
575       local res = {f()}
576       buffer = tableconcat(buffer)
577       if buffer and buffer ~= "" then
578         return buffer
```

```

579     end
580     buffer = {}
581     mpprint(buffer, tableunpack(res))
582     return tableconcat(buffer)
583 end
584 return ""
585 end
586 end
587

```

luamplib.maketext

```

588 luamplib.legacyverbatimtex = true
589 do

```

make_text must be one liner, so comment sign is not allowed.

```

590 local function protecttexcontents (str)
591     return str:gsub("\\%", "\\0PerCent\0")
592           :gsub("%%.\n", "")
593           :gsub("%%.-$", "")
594           :gsub("%zPerCent%z", "\\%")
595           :gsub("\r.-$", "")
596           :gsub("%s+", " ")
597 end
598 function luamplib.maketext (str, what)
599     if str and str ~= "" then
600         str = protecttexcontents(str)
601         if what == 1 then
602             if not str:find("\\documentclass"..name_e) and
603                not str:find("\\begin%s*{document}") and
604                not str:find("\\documentstyle"..name_e) and
605                not str:find("\\usepackage"..name_e) then
606                 if luamplib.legacyverbatimtex then
607                     if luamplib.in_the_fig then
608                         return process_verbatimtex_infig(str)
609                     else
610                         return process_verbatimtex_prefig(str)
611                     end
612                 else
613                     return process_verbatimtex_text(str)
614                 end
615             end
616         else
617             return process_tex_text(str, true) -- bool is for 'char13'
618         end
619     end
620     return ""
621 end
622 end
623

```

luamplib's METAPOST color operators

```

624 luamplib.gettexcolor = function (str, rgb)
625   local res = process_color(str):match'"mpliboverridecolor=(.+)"'
626   if res:find" cs " or res:find"@pdf.obj" then
627     if not rgb then
628       warn("%s is a spot color. Forced to CMYK", str)
629     end
630     run_tex_code({
631       "\\color_export:nnN{" ,
632       str,
633       "}" ,
634       rgb and "space-sep-rgb" or "space-sep-cmyk",
635       "}" \\mplib@tempa",
636     }, ccexplat)
637     return get_macro"mplib@tempa":explode()
638   end
639   local t = colorsplit(res)
640   if #t == 3 or not rgb then return t end
641   if #t == 4 then
642     return { 1 - math.min(1,t[1]+t[4]), 1 - math.min(1,t[2]+t[4]), 1 - math.min(1,t[3]+t[4]) }
643   end
644   return { t[1], t[1], t[1] }
645 end
646
647 luamplib.shadecolor = function (str)
648   local res = process_color(str):match'"mpliboverridecolor=(.+)"'
649   if res:find" cs " or res:find"@pdf.obj" then -- spot color shade: 13 only

```

An example of spot color shading:

```

\DocumentMetadata{ }
\documentclass{article}
\usepackage{luamplib}
\ExplSyntaxOn
\color_model_new:nnn { pantone3005 }
{ Separation }
{
  name = PANTONE~3005~U ,
  alternative-model = cmyk ,
  alternative-values = {1, 0.56, 0, 0}
}
\color_set:nnn{spotA}{pantone3005}{1}
\color_set:nnn{spotB}{pantone3005}{0.6}
\color_model_new:nnn { pantone1215 }
{ Separation }
{
  name = PANTONE~1215~U ,
  alternative-model = cmyk ,
  alternative-values = {0, 0.15, 0.51, 0}
}
\color_set:nnn{spotC}{pantone1215}{1}
\color_model_new:nnn { pantone2040 }

```

```

{ Separation }
{
  name = PANTONE~2040~U ,
  alternative-model = cmyk ,
  alternative-values = {0, 0.28, 0.21, 0.04}
}
\color_set:nnn{spotD}{pantone2040}{1}
\ExplSyntaxOff
\begin{document}
\begin{mplibcode}
beginfig(1)
  fill unitsquare xscaled \mpdim\textwidth yscaled 1cm
    withshadingmethod "linear"
    withshadingvector (0,1)
    withshadingstep (
      withshadingfraction .5
      withshadingcolors ("spotB","spotC")
    )
    withshadingstep (
      withshadingfraction 1
      withshadingcolors ("spotC","spotD")
    )
  ;
endfig;
\end{mplibcode}
\end{document}

```

another one: user-defined DeviceN colorspace

```

\DocumentMetadata{ }
\documentclass{article}
\usepackage{luamplib}
\ExplSyntaxOn
\color_model_new:nnn { pantone1215 }
{ Separation }
{
  name = PANTONE~1215~U ,
  alternative-model = cmyk ,
  alternative-values = {0, 0.15, 0.51, 0}
}
\color_model_new:nnn { pantone+black }
{ DeviceN }
{ names = {pantone1215,black} }
\color_set:nnn{purepantone}{pantone+black}{1,0}
\color_set:nnn{pureblack} {pantone+black}{0,1}
\ExplSyntaxOff
\begin{document}
\mpfig
  fill unitsquare xscaled \mpdim{\textwidth} yscaled 30
    withshadingmethod "linear"

```

```

        withshadingcolors ("purepantone","pureblack")
    ;
\endmpfig
\end{document}

650 run_tex_code({
651     [[\color_export:nnN{]], str, [[]{backend}\mplib@tempa]],
652     },ccexplat)
653 local name, value = get_macro'mplib@tempa':match'{{(.-)}}{(.-)}'
654 local t, obj = res:explode()
655 if pdfmode then
656     obj = format("%s 0 R", ltx.pdf.object_id( t[1]:sub(2,-1) ))
657 else
658     obj = t[2]
659 end
660 return format('(1) withprescript"mplib_spotcolor=%s:%s:%s"', value,obj,name)
661 end
662 return colorsplit(res)
663 end
664

luamplib.fillandstrokecolor
665 do
666 local function graphicstextcolor (col, filldraw)
667     if col:find"^[%d%.:]+$" then
668         col = col:explode"."
669         for i=1,#col do
670             col[i] = format("%.3f", col[i])
671         end
672         if pdfmode then
673             local op = #col == 4 and "k" or #col == 3 and "rg" or "g"
674             col[#col+1] = filldraw == "fill" and op or op:upper()
675             return tableconcat(col," ")
676         end
677         return format("[%s]", tableconcat(col," "))
678     end
679     col = process_color(col):match'"mpliboverridecolor=(.)"'
680     if pdfmode then
681         local t = col:explode()
682         local b = filldraw == "fill" and 1 or #t/2+1
683         local e = b == 1 and #t/2 or #t
684         return tableconcat(t," ", b, e)
685     end
686     return format("[%s]", tableconcat(colorsplit(col)," "))
687 end
688 function luamplib.fillandstrokecolor (fill, stroke)
689     fill = graphicstextcolor(fill, "fill")
690     stroke = graphicstextcolor(stroke, "stroke")
691     local bc = pdfmode and "" or "pdf:bc "
692     return format('withprescript "mpliboverridecolor=%s%s %s"', bc, fill, stroke)

```



```

693 end
694 end
695

```

Remove trailing zeros for smaller PDF

```

696 local decimals = "%.d+"
697 local function rmzeros(str) return str:gsub("%.?0+$", "") end
698

```

common function for mplibgraphicstext and mpliboutlinetext

```

699 local function getrulemetric (box, curr, bp)
700   local running = -1073741824
701   local wd,ht,dp = curr.width, curr.height, curr.depth
702   wd = wd == running and box.width or wd
703   ht = ht == running and box.height or ht
704   dp = dp == running and box.depth or dp
705   if bp then
706     return wd/factor, ht/factor, dp/factor
707   end
708   return wd, ht, dp
709 end
710

```

luamplib's mplibgraphicstext operator

```

711 do
712   local emboldenfonts = { }
713   local function getemboldenwidth (curr, fakebold)
714     local width = emboldenfonts.width
715     if not width then
716       local f
717       local function getglyph(n)
718         while n do
719           if n.head then
720             getglyph(n.head)
721           elseif n.font and n.font > 0 then
722             f = n.font; break
723           end
724           n = node.getnext(n)
725         end
726       end
727       getglyph(curr)
728       width = font.getcopy(f or font.current()).size * fakebold / factor * 10
729       emboldenfonts.width = width
730     end
731     return width
732   end
733   local function getrulewhatsit (line, wd, ht, dp)
734     line, wd, ht, dp = line/1000, wd/factor, ht/factor, dp/factor
735     local pl
736     local fmt = "%f w %f %f %f %f re %s"

```

```

737   if pdfmode then
738     pl = node.new("whatsit","pdf_literal")
739     pl.mode = 0
740   else
741     fmt = "pdf:content " ..fmt
742     pl = node.new("whatsit","special")
743   end
744   pl.data = fmt:format(line, 0, -dp, wd, ht+dp, "B") :gsub(decimals,rmzeros)
745   local ss = node.new"glue"
746   node.setglue(ss, 0, 65536, 65536, 2, 2)
747   pl.next = ss
748   return pl
749 end

```

copying attributes of rule/glue node to improve tagging of mplibgraphicstext

```

750 local tag_update_attrs
751 if is_defined"ver@tagpdf.sty" then
752   tag_update_attrs = function (n, curr)
753     while n do
754       n.attr = curr.attr
755       if n.head then
756         tag_update_attrs(n.head, curr)
757       end
758       n = node.getnext(n)
759     end
760   end
761 else
762   tag_update_attrs = function() end
763 end
764 local function embolden (box, curr, fakebold)
765   local head = curr
766   while curr do
767     if curr.head then
768       curr.head = embolden(curr, curr.head, fakebold)
769     elseif curr.replace then
770       curr.replace = embolden(box, curr.replace, fakebold)
771     elseif curr.leader then
772       if curr.leader.head then
773         curr.leader.head = embolden(curr.leader, curr.leader.head, fakebold)
774       elseif curr.leader.id == node.id"rule" then
775         local glue = node.effective_glue(curr, box)
776         local line = getemboldenwidth(curr, fakebold)
777         local wd,ht,dp = getrulemetric(box, curr.leader)
778         if box.id == node.id"hlist" then
779           wd = glue
780         else
781           ht, dp = 0, glue
782         end
783         local pl = getrulewhatsit(line, wd, ht, dp)

```

```

784     local pack = box.id == node.id"hlist" and node.hpack or node.vpack
785     local list = pack(pl, glue, "exactly")
786     tag_update_attrs(list,curr)
787     head = node.insert_after(head, curr, list)
788     head, curr = node.remove(head, curr)
789     end
790 elseif curr.id == node.id"rule" and curr.subtype == 0 then
791     local line = getemboldenwidth(curr, fakebold)
792     local wd,ht,dp = getrulemetric(box, curr)
793     if box.id == node.id"vlist" then
794         ht, dp = 0, ht+dp
795     end
796     local pl = getrulewhatsit(line, wd, ht, dp)
797     local list
798     if box.id == node.id"hlist" then
799         list = node.hpack(pl, wd, "exactly")
800     else
801         list = node.vpack(pl, ht+dp, "exactly")
802     end
803     tag_update_attrs(list,curr)
804     head = node.insert_after(head, curr, list)
805     head, curr = node.remove(head, curr)
806 elseif curr.id == node.id"glyph" and curr.font > 0 then
807     local f = curr.font
808     local key = format("%s:%s",f,fakebold)
809     local i = emboldenfonts[key]
810     if not i then
811         local ft = font.getfont(f) or font.getcopy(f)
812         if pdfmode then
813             width = ft.size * fakebold / factor * 10
814             emboldenfonts.width = width
815             ft.mode, ft.width = 2, width
816             i = font.define(ft)
817         else
818             if ft.format ~= "opentype" and ft.format ~= "truetype" then
819                 goto skip_type1
820             end
821             local name = ft.name:gsub('","'):gsub(';','$','')
822             name = format('%s;embolden=%s;',name,fakebold)
823             _, i = fonts.constructors.readanddefine(name,ft.size)
824         end
825         emboldenfonts[key] = i
826     end
827     curr.font = i
828 end
829 ::skip_type1::
830 curr = node.getnext(curr)
831 end
832 return head

```

```

833 end
834 luamplib.graphicstext = function (text, fakebold, fc, dc)
835     local fmt = process_tex_text(text):sub(1,-2)
836     local id = tonumber(fmt:match"mplibtexboxid=(%d+):")
837     emboldenfonts.width = nil
838     local box = texgetbox(id)
839     box.head = embolden(box, box.head, fakebold)
840     local colors = luamplib.fillandstrokecolor(fc, dc)
841     return format('%s %s)', fmt, colors)
842 end
843 end
844

```

luamplib's mplibglyph operator

```

845 do
846     local function mperr (str)
847         return format("hide(errmessage %q)", str)
848     end
849     local function getangle (a,b,c)
850         local r = math.deg(math.atan(c.y-b.y, c.x-b.x) - math.atan(b.y-a.y, b.x-a.x))
851         if r > 180 then
852             r = r - 360
853         elseif r < -180 then
854             r = r + 360
855         end
856         return r
857     end
858     local function turning (t)
859         local r, n = 0, #t
860         for i=1,2 do
861             tableinsert(t, t[i])
862         end
863         for i=1,n do
864             r = r + getangle(t[i], t[i+1], t[i+2])
865         end
866         return r/360
867     end
868     local function glyphimage(t, fmt)
869         local q,p,r = {{},{}}
870         for i,v in ipairs(t) do
871             local cmd = v[#v]
872             if cmd == "m" then
873                 p = {format('(%s,%s)',v[1],v[2])}
874                 r = {{x=v[1],y=v[2]}}
875             else
876                 local nt = t[i+1]
877                 local last = not nt or nt[#nt] == "m"
878                 if cmd == "l" then
879                     local pt = t[i-1]

```

```

880     local seco = pt[#pt] == "m"
881     if (last or seco) and r[1].x == v[1] and r[1].y == v[2] then
882     else
883         tableinsert(p, format('--(%s,%s)',v[1],v[2]))
884         tableinsert(r, {x=v[1],y=v[2]})
885     end
886     if last then
887         tableinsert(p, '--cycle')
888     end
889 elseif cmd == "c" then
890     tableinsert(p, format('..controls(%s,%s)and(%s,%s)',v[1],v[2],v[3],v[4]))
891     if last and r[1].x == v[5] and r[1].y == v[6] then
892         tableinsert(p, '..cycle')
893     else
894         tableinsert(p, format('..(%s,%s)',v[5],v[6]))
895         if last then
896             tableinsert(p, '--cycle')
897         end
898         tableinsert(r, {x=v[5],y=v[6]})
899     end
900 else
901     return mperr"unknown operator"
902 end
903 if last then
904     tableinsert(q[ turning(r) > 0 and 1 or 2 ], tableconcat(p))
905 end
906 end
907 end
908 r = { }
909 if fmt == "opentype" then
910     for _,v in ipairs(q[1]) do
911         tableinsert(r, format('addto currentpicture contour %s;',v))
912     end
913     for _,v in ipairs(q[2]) do
914         tableinsert(r, format('addto currentpicture contour %s withcolor background;',v))
915     end
916 else
917     for _,v in ipairs(q[2]) do
918         tableinsert(r, format('addto currentpicture contour %s;',v))
919     end
920     for _,v in ipairs(q[1]) do
921         tableinsert(r, format('addto currentpicture contour %s withcolor background;',v))
922     end
923 end
924 return format('image(%s)', tableconcat(r))
925 end
926 if not table.tofile then require"lualibs-lpeg"; require"lualibs-table"; end
927 function luamplib.glyph (f, c)
928     local filename, subfont, instance, kind, shapedata

```

```

929 local fid = tonumber(f) or font.id(f)
930 if fid > 0 then
931     local fontdata = font.getfont(fid) or font.getcopy(fid)
932     filename, subfont, kind = fontdata.filename, fontdata.subfont, fontdata.format
933     instance = fontdata.specification and fontdata.specification.instance
934     filename = filename and filename:gsub("^harfloaded:", "")
935 else
936     local name
937     f = f:match"^%s*(.)%s*$"
938     name, subfont, instance = f:match"(.+)%((%d+)%)%[(.-)]%"
939     if not name then
940         name, instance = f:match"(.+)%[(.-)]%" -- SourceHanSansK-VF.otf[Heavy]
941     end
942     if not name then
943         name, subfont = f:match"(.+)%((%d+)%)$" -- Times.ttc(2)
944     end
945     name = name or f
946     subfont = (subfont or 0)+1
947     instance = instance and instance:lower()
948     for _, ftype in ipairs{"opentype", "truetype"} do
949         filename = kpse.find_file(name, ftype.." fonts")
950         if filename then
951             kind = ftype; break
952         end
953     end
954 end
955 if kind ~= "opentype" and kind ~= "truetype" then
956     f = fid and fid > 0 and tex.fontname(fid) or f
957     if kpse.find_file(f, "tfm") then
958         return format("glyph %s of %q", tonumber(c) or format("%q", c), f)
959     else
960         return mperr"font not found"
961     end
962 end
963 local time = lfsattributes(filename, "modification")
964 local k = format("shapes_%s(%s)[%s]", filename, subfont or "", instance or "")
965 local h = format(string.rep('%02x', 256/8), string.byte(sha2.digest256(k), 1, -1))
966 local newname = format("%s/%s.lua", cachedir or outputdir, h)
967 local newtime = lfsattributes(newname, "modification") or 0
968 if time == newtime then
969     shapedata = require(newname)
970 end
971 if not shapedata then
972     shapedata = fonts and fonts.handlers.otf.readers.loadshapes(filename, subfont, instance)
973     if not shapedata then return mperr"loadshapes() failed. luaotfload not loaded?" end
974     table.tofile(newname, shapedata, "return")
975     lfstouch(newname, time, time)
976 end
977 local gid = tonumber(c)

```

```

978     if not gid then
979         local uni = utf8.codepoint(c)
980         for i,v in pairs(shapedata.glyphs) do
981             if c == v.name or uni == v.unicode then
982                 gid = i; break
983             end
984         end
985     end
986     if not gid then return mperr"cannot get GID (glyph id)" end
987     local fac = 1000 / (shapedata.units or 1000)
988     local t = shapedata.glyphs[gid].segments
989     if not t then return "image()" end
990     for i,v in ipairs(t) do
991         if type(v) == "table" then
992             for ii,vv in ipairs(v) do
993                 if type(vv) == "number" then
994                     t[i][ii] = format("%.0f", vv * fac)
995                 end
996             end
997         end
998     end
999     kind = shapedata.format or kind
1000     return glyphimage(t, kind)
1001 end
1002 end
1003

```

mpliboutline : based on mkiv's font-mps.lua

```

1004 do
1005     local rulefmt = "mpliboutlinepic[%i]:=image(addto currentpicture contour \z
1006         unitsquare shifted - center unitsquare;) xscaled %f yscaled %f shifted (%f,%f);"
1007     local outline_horz, outline_vert
1008     function outline_vert (res, box, curr, xshift, yshift)
1009         local b2u = box.dir == "LTL"
1010         local dy = (b2u and -box.depth or box.height)/factor
1011         local ody = dy
1012         while curr do
1013             if curr.id == node.id"rule" then
1014                 local wd, ht, dp = getrulemetric(box, curr, true)
1015                 local hd = ht + dp
1016                 if hd ~= 0 then
1017                     dy = dy + (b2u and dp or -ht)
1018                     if wd ~= 0 and curr.subtype == 0 then
1019                         res[#res+1] = rulefmt:format(#res+1, wd, hd, xshift+wd/2, yshift+dy+(ht-dp)/2)
1020                     end
1021                     dy = dy + (b2u and ht or -dp)
1022                 end
1023             elseif curr.id == node.id"glue" then
1024                 local vwidth = node.effective_glue(curr,box)/factor

```

```

1025     if curr.lead then
1026         local curr, kind = curr.lead, curr.subtype
1027         if curr.id == node.id"rule" then
1028             local wd = getrulemetric(box, curr, true)
1029             if wd ~= 0 then
1030                 local hd = vwidth
1031                 local dy = dy + (b2u and 0 or -hd)
1032                 if hd ~= 0 and curr.subtype == 0 then
1033                     res[#res+1] = rulefmt:format(#res+1, wd, hd, xshift+wd/2, yshift+dy+hd/2)
1034                 end
1035             end
1036         elseif curr.head then
1037             local hd = (curr.height + curr.depth)/factor
1038             if hd <= vwidth then
1039                 local dy, n, iy = dy, 0, 0
1040                 if kind == 100 or kind == 103 then -- todo: gleaders
1041                     local ady = abs(ody - dy)
1042                     local ndy = math.ceil(ady / hd) * hd
1043                     local diff = ndy - ady
1044                     n = math.floor((vwidth-diff) / hd)
1045                     dy = dy + (b2u and diff or -diff)
1046                 else
1047                     n = math.floor(vwidth / hd)
1048                     if kind == 101 then
1049                         local side = vwidth % hd / 2
1050                         dy = dy + (b2u and side or -side)
1051                     elseif kind == 102 then
1052                         iy = vwidth % hd / (n+1)
1053                         dy = dy + (b2u and iy or -iy)
1054                     end
1055                 end
1056                 dy = dy + (b2u and curr.depth or -curr.height)/factor
1057                 hd = b2u and hd or -hd
1058                 iy = b2u and iy or -iy
1059                 local func = curr.id == node.id"hlist" and outline_horz or outline_vert
1060                 for i=1,n do
1061                     res = func(res, curr, curr.head, xshift+curr.shift/factor, yshift+dy)
1062                     dy = dy + hd + iy
1063                 end
1064             end
1065         end
1066     end
1067     dy = dy + (b2u and vwidth or -vwidth)
1068 elseif curr.id == node.id"kern" then
1069     dy = dy + curr.kern/factor * (b2u and 1 or -1)
1070 elseif curr.id == node.id"vlist" then
1071     dy = dy + (b2u and curr.depth or -curr.height)/factor
1072     res = outline_vert(res, curr, curr.head, xshift+curr.shift/factor, yshift+dy)
1073     dy = dy + (b2u and curr.height or -curr.depth)/factor

```



```

1074     elseif curr.id == node.id"hlist" then
1075         dy = dy + (b2u and curr.depth or -curr.height)/factor
1076         res = outline_horz(res, curr, curr.head, xshift+curr.shift/factor, yshift+dy)
1077         dy = dy + (b2u and curr.height or -curr.depth)/factor
1078     end
1079     curr = node.getnext(curr)
1080 end
1081 return res
1082 end
1083 function outline_horz (res, box, curr, xshift, yshift, discwd)
1084     local r2l = box.dir == "TRT"
1085     local dx = r2l and (discwd or box.width/factor) or 0
1086     local dirs = { { dir = r2l, dx = dx } }
1087     while curr do
1088         if curr.id == node.id"dir" then
1089             local sign, dir = curr.dir:match"(.)(...)"
1090             local level, newdir = curr.level, r2l
1091             if sign == "+" then
1092                 newdir = dir == "TRT"
1093                 if r2l ~= newdir then
1094                     local n = node.getnext(curr)
1095                     while n do
1096                         if n.id == node.id"dir" and n.level+1 == level then break end
1097                         n = node.getnext(n)
1098                     end
1099                     n = n or node.tail(curr)
1100                     dx = dx + node.rangedimensions(box, curr, n)/factor * (newdir and 1 or -1)
1101                 end
1102                 dirs[level] = { dir = r2l, dx = dx }
1103             else
1104                 local level = level + 1
1105                 newdir = dirs[level].dir
1106                 if r2l ~= newdir then
1107                     dx = dirs[level].dx
1108                 end
1109             end
1110             r2l = newdir
1111         elseif curr.char and curr.font and curr.font > 0 then
1112             local ft = font.getfont(curr.font) or font.getcopy(curr.font)
1113             local gid = ft.characters[curr.char].index or curr.char
1114             local scale = ft.size / factor / 1000
1115             local slant = (ft.slant or 0)/1000
1116             local extend = (ft.extend or 1000)/1000
1117             local squeeze = (ft.squeeze or 1000)/1000
1118             local expand = 1 + (curr.expansion_factor or 0)/1000000
1119             local xscale, yscale = scale * extend * expand, scale * squeeze
1120             dx = dx - (r2l and curr.width/factor*expand or 0)
1121             local xoff, yoff = (curr.xoffset or 0)/factor, (curr.yoffset or 0)/factor
1122             local xpos, ypos = dx + xshift + xoff, yshift + yoff

```

```

1123     local vertical = ""
1124     if ft.shared and (ft.shared.features.vert or ft.shared.features.vrt2) then
1125         if ft.shared.features.vertical then -- luatexko
1126             vertical = "rotated 90"
1127             local data = ft.characters[curr.char] or { }
1128             if ft.hb then
1129                 local hoff, voff = (data.luatexko_hoff or 0)/factor, (data.luatexko_voff or 0)/factor
1130                 local charraise = (ft.luatexko_charraise or 0)/factor
1131                 xpos, ypos = xpos - voff + hoff - charraise, ypos + hoff + voff + charraise
1132             else
1133                 local cmds = data.commands or { {0,0}, {0,0} }
1134                 local voff, hoff = -cmds[1][2]/factor, cmds[2][2]/factor
1135                 xpos, ypos = xpos + hoff, ypos + voff
1136             end
1137         elseif curr ~= box.head then -- luatexja
1138             vertical = "rotated 90"
1139             local en = ft.parameters.quad/factor/2
1140             xpos, ypos = xpos - xoff - yoff + en, ypos - yoff + xoff - en
1141         end
1142     end
1143     local image
1144     if ft.format == "opentype" or ft.format == "truetype" then
1145         image = luamplib.glyph(curr.font, gid)
1146     else
1147         local name, scale = ft.name, 1
1148         local vf = font.read_vf(name, ft.size)
1149         if vf and vf.characters[gid] then
1150             local cmds = vf.characters[gid].commands or { }
1151             for _,v in ipairs(cmds) do
1152                 if v[1] == "char" then
1153                     gid = v[2]
1154                 elseif v[1] == "font" and vf.fonts[v[2]] then
1155                     name = vf.fonts[v[2]].name
1156                     scale = vf.fonts[v[2]].size / ft.size
1157                 end
1158             end
1159         end
1160         image = format("glyph %s of %q scaled %f", gid, name, scale)
1161     end
1162     res[#res+1] = format("mpliboutlinepic[%i]:= %s xscaled %f yscaled %f slanted %f %s shifted (%f,%f);",
1163         #res+1, image, xscale, yscale, slant, vertical, xpos, ypos)
1164     dx = dx + (r2l and 0 or curr.width/factor*expand)
1165 elseif curr.replace then
1166     local width = node.dimensions(curr.replace)/factor
1167     dx = dx - (r2l and width or 0)
1168     res = outline_horz(res, box, curr.replace, xshift+dx, yshift, width)
1169     dx = dx + (r2l and 0 or width)
1170 elseif curr.id == node.id"rule" then
1171     local wd, ht, dp = getrulemetric(box, curr, true)

```

```

1172     if wd ~= 0 then
1173         local hd = ht + dp
1174         dx = dx - (r2l and wd or 0)
1175         if hd ~= 0 and curr.subtype == 0 then
1176             res[#res+1] = rulefmt:format(#res+1, wd, hd, xshift+dx+wd/2, yshift+(ht-dp)/2)
1177         end
1178         dx = dx + (r2l and 0 or wd)
1179     end
1180 elseif curr.id == node.id"glue" then
1181     local width = node.effective_glue(curr, box)/factor
1182     dx = dx - (r2l and width or 0)
1183     if curr.leader then
1184         local curr, kind = curr.leader, curr.subtype
1185         if curr.id == node.id"rule" then
1186             local wd, ht, dp = getrulemetric(box, curr, true)
1187             local hd = ht + dp
1188             if hd ~= 0 then
1189                 wd = width
1190                 if wd ~= 0 and curr.subtype == 0 then
1191                     res[#res+1] = rulefmt:format(#res+1, wd, hd, xshift+dx+wd/2, yshift+(ht-dp)/2)
1192                 end
1193             end
1194         elseif curr.head then
1195             local wd = curr.width/factor
1196             if wd <= width then
1197                 local dx = r2l and dx+width or dx
1198                 local n, ix = 0, 0
1199                 if kind == 100 or kind == 103 then -- todo: gleaders
1200                     local adx = abs(dx-dirs[1].dx)
1201                     local ndx = math.ceil(adx / wd) * wd
1202                     local diff = ndx - adx
1203                     n = math.floor((width-diff) / wd)
1204                     dx = dx + (r2l and -diff-wd or diff)
1205                 else
1206                     n = math.floor(width / wd)
1207                     if kind == 101 then
1208                         local side = width % wd / 2
1209                         dx = dx + (r2l and -side-wd or side)
1210                     elseif kind == 102 then
1211                         ix = width % wd / (n+1)
1212                         dx = dx + (r2l and -ix-wd or ix)
1213                     end
1214                 end
1215                 wd = r2l and -wd or wd
1216                 ix = r2l and -ix or ix
1217                 local func = curr.id == node.id"hlist" and outline_horz or outline_vert
1218                 for i=1,n do
1219                     res = func(res, curr, curr.head, xshift+dx, yshift-curr.shift/factor)
1220                     dx = dx + wd + ix

```

```

1221         end
1222     end
1223 end
1224 end
1225     dx = dx + (r2l and 0 or width)
1226 elseif curr.id == node.id" kern" then
1227     dx = dx + curr.kern/factor * (r2l and -1 or 1)
1228 elseif curr.id == node.id" math" then
1229     dx = dx + curr.surround/factor * (r2l and -1 or 1)
1230 elseif curr.id == node.id" vlist" then
1231     dx = dx - (r2l and curr.width/factor or 0)
1232     res = outline_vert(res, curr, curr.head, xshift+dx, yshift-curr.shift/factor)
1233     dx = dx + (r2l and 0 or curr.width/factor)
1234 elseif curr.id == node.id" hlist" then
1235     dx = dx - (r2l and curr.width/factor or 0)
1236     res = outline_horz(res, curr, curr.head, xshift+dx, yshift-curr.shift/factor)
1237     dx = dx + (r2l and 0 or curr.width/factor)
1238 end
1239     curr = node.getnext(curr)
1240 end
1241 return res
1242 end
1243 function luamplib.outlinetext (text)
1244     local fmt = process_tex_text(text)
1245     local id = tonumber(fmt:match"mplibtexboxid=(%d+):")
1246     local box = texgetbox(id)
1247     local res = outline_horz({ }, box, box.head, 0, 0)
1248     if #res == 0 then res = { "mpliboutlinepic[1]:=image();" } end
1249     return tableconcat(res) .. format("mpliboutlinenum:=%i;", #res)
1250 end
1251 end
1252

```

lua functions for mplib(uc)substring ... of ...

```

1253 function luamplib.getunicodegraphemes (s)
1254     local t = { }
1255     local graphemes = require'lua-uni-graphemes'
1256     for _, _, c in graphemes.graphemes(s) do
1257         table.insert(t, c)
1258     end
1259     return t
1260 end
1261 function luamplib.unicodesubstring (s,b,e,grph)
1262     local tt, t, step = { }
1263     if grph then
1264         t = luamplib.getunicodegraphemes(s)
1265     else
1266         t = { }
1267         for _, c in utf8.codes(s) do

```

```

1268     table.insert(t, utf8.char(c))
1269   end
1270 end
1271 if b <= e then
1272   b, step = b+1, 1
1273 else
1274   e, step = e+1, -1
1275 end
1276 for i = b, e, step do
1277   table.insert(tt, t[i])
1278 end
1279 s = table.concat(tt):gsub("'", "'&ditto'")
1280 return string.format("%s", s)
1281 end
1282

```

METAPOST preambles

```

1283 luamplib.preambles = {
1284   preamble = [[
1285 boolean mplib ; mplib := true ;
1286 let dump = endinput ;
1287 let normalfontsize = fontsize;
1288 input %s ;
1289 ]],
1290   mplibcode = [[
1291 texscriptmode := 2;
1292 def rawtexttext primary t = runscript("luamplibtext{"&t&"}") enddef;
1293 def mplibcolor primary t = runscript("luamplibcolor{"&t&"}") enddef;
1294 def mplibdimen primary t = runscript("luamplibdimen{"&t&"}") enddef;
1295 def VerbatimTeX primary t = runscript("luamplibverbtex{"&t&"}") enddef;
1296 if known context_mlib:
1297   defaultfont := "cmitt10";
1298   let infont = normalinfont;
1299   let fontsize = normalfontsize;
1300   vardef thelabel@#(expr p,z) =
1301     if string p :
1302       thelabel@#(p infont defaultfont scaled defaultscale,z)
1303     else :
1304       p shifted (z + labeloffset*mfun_laboff@# -
1305         (mfun_labxf@#*lrcorner p + mfun_labyf@#*ulcorner p +
1306         (1-mfun_labxf@#-mfun_labyf@#)*llcorner p))
1307     fi
1308   enddef;
1309 else:
1310   vardef texttext@# primary t = rawtexttext (t) enddef;
1311   def message expr t =
1312     if string t: runscript("mp.report[="&t&"]=]") else: errmessage "Not a string" fi
1313   enddef;
1314   def withtransparency (expr a, t) =

```

```

1315   withprescript "tr_alternative=" & if numeric a: decimal fi a
1316   withprescript "tr_transparency=" & decimal t
1317   enddef;
1318   vardef ddecimal primary p =
1319     decimal xpart p & " " & decimal ypart p
1320   enddef;
1321   vardef boundingbox primary p =
1322     if (path p) or (picture p) :
1323       llcorner p -- lrcorner p -- urcorner p -- ulcorner p
1324     else :
1325       origin
1326     fi -- cycle
1327   enddef;
1328   fi
1329   def resolvedcolor(expr s) =
1330     runscript("return luamplib.shadecolor('& s &')")
1331   enddef;
1332   def colordecimals primary c =
1333     if cmykcolor c:
1334       decimal cyanpart c & ":" & decimal magentapart c & ":" &
1335       decimal yellowpart c & ":" & decimal blackpart c
1336     elseif rgbcolor c:
1337       decimal redpart c & ":" & decimal greenpart c & ":" & decimal bluepart c
1338     elseif string c:
1339       if known graphicstextpic: c else: colordecimals resolvedcolor(c) fi
1340     else:
1341       decimal c
1342     fi
1343   enddef;
1344   def externalfigure primary filename =
1345     draw rawtexttext("\includegraphics{"& filename &}")
1346   enddef;
1347   def TEX = texttext enddef;
1348   def mplibtexcolor primary c =
1349     runscript("return luamplib.gettexcolor('& c &')")
1350   enddef;
1351   def mplibrgbtexcolor primary c =
1352     runscript("return luamplib.gettexcolor('& c &', 'rgb')")
1353   enddef;
1354   def mplibgraphicstext primary t =
1355     begingroup;
1356     mplibgraphicstext_ (t)
1357   enddef;
1358   def mplibgraphicstext_ (expr t) text rest =
1359     save fakebold, scale, fillcolor, drawcolor, withfillcolor, withdrawcolor, strokecolor,
1360     fb, fc, dc, graphicstextpic, alsoordoublepath;
1361     picture graphicstextpic; graphicstextpic := nullpicture;
1362     numeric fb; string fc, dc; fb:=2; fc:="white"; dc:="black";
1363     let scale = scaled;

```

```

1364 def fakebold primary c = hide(fb:=c;) enddef;
1365 def fillcolor primary c = hide(fc:=colordecimals c;) enddef;
1366 def drawcolor primary c = hide(dc:=colordecimals c;) enddef;
1367 let withfillcolor = fillcolor; let withdrawcolor = drawcolor; let strokecolor = drawcolor;
1368 def alsoordoublepath expr p = if picture p: also else: doublepath fi p enddef;
1369 addto graphictextpic alsoordoublepath (origin--cycle) rest; graphictextpic:=nullpicture;
1370 def fakebold primary c = enddef;
1371 let fillcolor = fakebold; let drawcolor = fakebold;
1372 let withfillcolor = fillcolor; let withdrawcolor = drawcolor; let strokecolor = drawcolor;
1373 image(draw runscript("return luamplib.graphictext([==["&t&"]==], "
1374   & decimal fb & ", "& fc & ", "& dc & "'')") rest;))
1375 endgroup;
1376 enddef;
1377 def mplibglyph expr c of f =
1378   runscript (
1379     "return luamplib.glyph('"
1380     & if numeric f: decimal fi f
1381     & "'',"
1382     & if numeric c: decimal fi c
1383     & "')"
1384   )
1385 enddef;
1386 numeric luamplib_tmp_num_; luamplib_tmp_num_ = 0;
1387 def mplibdrawglyph expr g =
1388   luamplib_tmp_num_ := 0;
1389   for item within g:
1390     fill pathpart item
1391     if incr luamplib_tmp_num_ < length g: withpostscript "collect"; fi
1392   endfor
1393 enddef;
1394 let mplibfillglyph = mplibdrawglyph;
1395 def mplibstrokeglyph expr g =
1396   luamplib_tmp_num_ := 0;
1397   for item within g:
1398     draw pathpart item
1399     if incr luamplib_tmp_num_ < length g: withpostscript "collect"; fi
1400   endfor
1401 enddef;
1402 def mplibfillandstrokeglyph expr g =
1403   luamplib_tmp_num_ := 0;
1404   for item within g:
1405     draw pathpart item withpostscript
1406     if incr luamplib_tmp_num_ < length g: "collect"; else: "both" fi
1407   endfor
1408 enddef;
1409 def withmplibcolors (expr f, s) =
1410   runscript("return luamplib.fillandstrokecolor('" &
1411     if not string f: colordecimals fi f & "''," &
1412     if not string s: colordecimals fi s & "')"

```

```

1413 enddef;
1414 def mplib_do_outline_text_set_b (text f) (text d) text r =
1415   def mplib_do_outline_options_f = f enddef;
1416   def mplib_do_outline_options_d = d enddef;
1417   def mplib_do_outline_options_r = r enddef;
1418 enddef;
1419 def mplib_do_outline_text_set_f (text f) text r =
1420   def mplib_do_outline_options_f = f enddef;
1421   def mplib_do_outline_options_r = r enddef;
1422 enddef;
1423 def mplib_do_outline_text_set_u (text f) text r =
1424   def mplib_do_outline_options_f = f enddef;
1425 enddef;
1426 def mplib_do_outline_text_set_d (text d) text r =
1427   def mplib_do_outline_options_d = d enddef;
1428   def mplib_do_outline_options_r = r enddef;
1429 enddef;
1430 def mplib_do_outline_text_set_r (text d) (text f) text r =
1431   def mplib_do_outline_options_d = d enddef;
1432   def mplib_do_outline_options_f = f enddef;
1433   def mplib_do_outline_options_r = r enddef;
1434 enddef;
1435 def mplib_do_outline_text_set_n text r =
1436   def mplib_do_outline_options_r = r enddef;
1437 enddef;
1438 def mplib_do_outline_text_set_p = enddef;
1439 def mplib_fill_outline_text =
1440   for n=1 upto mpliboutlinenum:
1441     i:=0;
1442     for item within mpliboutlinepic[n]:
1443       i:=i+1;
1444       fill pathpart item mplib_do_outline_options_f withpen pencircle scaled 0
1445       if (n<mpliboutlinenum) or (i<length mpliboutlinepic[n]): withpostscript "collect"; fi
1446     endfor
1447   endfor
1448 enddef;
1449 def mplib_draw_outline_text =
1450   for n=1 upto mpliboutlinenum:
1451     for item within mpliboutlinepic[n]:
1452       draw pathpart item mplib_do_outline_options_d;
1453     endfor
1454   endfor
1455 enddef;
1456 def mplib_filldraw_outline_text =
1457   for n=1 upto mpliboutlinenum:
1458     i:=0;
1459     for item within mpliboutlinepic[n]:
1460       i:=i+1;
1461       if (n<mpliboutlinenum) or (i<length mpliboutlinepic[n]):

```



```

1462     fill pathpart item mplib_do_outline_options_f withpostscript "collect";
1463     else:
1464         draw pathpart item mplib_do_outline_options_f withpostscript "both";
1465     fi
1466 endfor
1467 endfor
1468 enddef;
1469 vardef mpliboutlinetext@# (expr t) text rest =
1470   save kind; string kind; kind := str @#;
1471   save i; numeric i;
1472   picture mpliboutlinepic[]; numeric mpliboutlinenum;
1473   def mplib_do_outline_options_d = enddef;
1474   def mplib_do_outline_options_f = enddef;
1475   def mplib_do_outline_options_r = enddef;
1476   runscript("return luamplib.outlinetext[==["&t&"]==]");
1477   image ( addto currentpicture also image (
1478     if kind = "f":
1479       mplib_do_outline_text_set_f rest;
1480       mplib_fill_outline_text;
1481     elseif kind = "d":
1482       mplib_do_outline_text_set_d rest;
1483       mplib_draw_outline_text;
1484     elseif kind = "b":
1485       mplib_do_outline_text_set_b rest;
1486       mplib_fill_outline_text;
1487       mplib_draw_outline_text;
1488     elseif kind = "u":
1489       mplib_do_outline_text_set_u rest;
1490       mplib_filldraw_outline_text;
1491     elseif kind = "r":
1492       mplib_do_outline_text_set_r rest;
1493       mplib_draw_outline_text;
1494       mplib_fill_outline_text;
1495     elseif kind = "p":
1496       mplib_do_outline_text_set_p;
1497       mplib_draw_outline_text;
1498     else:
1499       mplib_do_outline_text_set_n rest;
1500       mplib_fill_outline_text;
1501     fi;
1502   ) mplib_do_outline_options_r; )
1503 enddef ;
1504 def withmppattern primary p =
1505   withprescript "mplibpattern=" & if numeric p: decimal fi p
1506 enddef;
1507 primarydef t withpattern p =
1508   image(
1509     if cycle t:
1510       fill

```

```

1511     else:
1512         draw
1513     fi
1514     t withprescript "mplibpattern=" & if numeric p: decimal fi p; )
1515 enddef;
1516 vardef mplibtransformmatrix (text e) =
1517     save t; transform t;
1518     t = identity e;
1519     runscript("luamplib.transformmatrix = {"
1520     & decimal xpart t & ","
1521     & decimal ypart t & ","
1522     & decimal xpart t & ","
1523     & decimal ypart t & ","
1524     & decimal xpart t & ","
1525     & decimal ypart t & ","
1526     & "}");
1527 enddef;
1528 primarydef p withfademethod s =
1529     if picture p:
1530         image(
1531             draw p;
1532             draw center p withprescript "mplibfadestate=stop";
1533         )
1534     else:
1535         p withprescript "mplibfadestate=stop"
1536     fi
1537     withprescript "mplibfadetype=" & s
1538     withprescript "mplibfadebbox=" &
1539         decimal (xpart llcorner p -1/4) & ":" &
1540         decimal (ypart llcorner p -1/4) & ":" &
1541         decimal (xpart urcorner p +1/4) & ":" &
1542         decimal (ypart urcorner p +1/4)
1543 enddef;
1544 def withfadeopacity (expr a,b) =
1545     withprescript "mplibfadeopacity=" &
1546         decimal a & ":" &
1547         decimal b
1548 enddef;
1549 def withfadevector (expr a,b) =
1550     withprescript "mplibfadevector=" &
1551         decimal xpart a & ":" &
1552         decimal ypart a & ":" &
1553         decimal xpart b & ":" &
1554         decimal ypart b
1555 enddef;
1556 let withfadecenter = withfadevector;
1557 def withfaderadius (expr a,b) =
1558     withprescript "mplibfaderadius=" &
1559         decimal a & ":" &

```

```

1560     decimal b
1561 enddef;
1562 def withfadebbox (expr a,b) =
1563   withprescript "mplibfadebbox=" &
1564     decimal xpart a & ":" &
1565     decimal ypart a & ":" &
1566     decimal xpart b & ":" &
1567     decimal ypart b
1568 enddef;
1569 primarydef p asgroup s =
1570   image(
1571     draw center p
1572       withprescript "mplibgroupbbox=" &
1573         decimal (xpart llcorner p -1/4) & ":" &
1574         decimal (ypart llcorner p -1/4) & ":" &
1575         decimal (xpart urcorner p +1/4) & ":" &
1576         decimal (ypart urcorner p +1/4)
1577       withprescript "gr_state=start"
1578       withprescript "gr_type=" & s;
1579     draw p;
1580     draw center p withprescript "gr_state=stop";
1581   )
1582 enddef;
1583 def withgroupbbox (expr a,b) =
1584   withprescript "mplibgroupbbox=" &
1585     decimal xpart a & ":" &
1586     decimal ypart a & ":" &
1587     decimal xpart b & ":" &
1588     decimal ypart b
1589 enddef;
1590 def withgroupname expr s =
1591   withprescript "mplibgroupname=" & s
1592 enddef;
1593 def usemplibgroup primary s =
1594   draw maketext("\luamplibtagasgroupput{"& s &"}{\csname luamplib.group."& s &"\endcsname}")
1595   shifted runscript("return luamplib.trgroupshifts['" & s & "']")
1596 enddef;
1597 path    mplib_shade_path ;
1598 numeric mplib_shade_step ; mplib_shade_step := 0 ;
1599 numeric mplib_shade_fx, mplib_shade_fy ;
1600 numeric mplib_shade_lx, mplib_shade_ly ;
1601 numeric mplib_shade_nx, mplib_shade_ny ;
1602 numeric mplib_shade_dx, mplib_shade_dy ;
1603 numeric mplib_shade_tx, mplib_shade_ty ;
1604 primarydef p withshadingmethod m =
1605   p
1606   if picture p :
1607     withprescript "sh_operand_type=picture"
1608     if textual p or (length p > 1):

```

```

1609     withprescript "sh_transform=no"
1610     mplib_with_shade_method (boundingbox p, m)
1611   else:
1612     withprescript "sh_transform=yes"
1613     mplib_with_shade_method (pathpart p, m)
1614   fi
1615 else :
1616   withprescript "sh_transform=yes"
1617   mplib_with_shade_method (p, m)
1618 fi
1619 enddef;
1620 def mplib_with_shade_method (expr p, m) =
1621   hide(mplib_with_shade_method_analyze(p))
1622   withprescript "sh_domain=0 1"
1623   withprescript "sh_color=into"
1624   withprescript "sh_color_a=" & colordecimals white
1625   withprescript "sh_color_b=" & colordecimals black
1626   withprescript "sh_first=" & ddecimal point 0 of p
1627   withprescript "sh_set_x=" & ddecimal (mplib_shade_nx,mplib_shade_lx)
1628   withprescript "sh_set_y=" & ddecimal (mplib_shade_ny,mplib_shade_ly)
1629   if m = "linear" :
1630     withprescript "sh_type=linear"
1631     withprescript "sh_factor=1"
1632     withprescript "sh_center_a=" & ddecimal llcorner p
1633     withprescript "sh_center_b=" & ddecimal urcorner p
1634   else :
1635     withprescript "sh_type=circular"
1636     withprescript "sh_factor=1.2"
1637     withprescript "sh_center_a=" & ddecimal center p
1638     withprescript "sh_center_b=" & ddecimal center p
1639     withprescript "sh_radius_a=" & decimal 0
1640     withprescript "sh_radius_b=" & decimal mplib_max_radius(p)
1641   fi
1642 enddef;
1643 def mplib_with_shade_method_analyze(expr p) =
1644   mplib_shade_path := p ;
1645   mplib_shade_step := 1 ;
1646   mplib_shade_fx   := xpart point 0 of p ;
1647   mplib_shade_fy   := ypart point 0 of p ;
1648   mplib_shade_lx   := mplib_shade_fx ;
1649   mplib_shade_ly   := mplib_shade_fy ;
1650   mplib_shade_nx   := 0 ;
1651   mplib_shade_ny   := 0 ;
1652   mplib_shade_dx   := abs(mplib_shade_fx - mplib_shade_lx) ;
1653   mplib_shade_dy   := abs(mplib_shade_fy - mplib_shade_ly) ;
1654   for i=1 upto length(p) :
1655     mplib_shade_tx := abs(mplib_shade_fx - xpart point i of p) ;
1656     mplib_shade_ty := abs(mplib_shade_fy - ypart point i of p) ;
1657     if mplib_shade_tx > mplib_shade_dx :

```

```

1658     mplib_shade_nx := i + 1 ;
1659     mplib_shade_lx := xpart point i of p ;
1660     mplib_shade_dx := mplib_shade_tx ;
1661   fi ;
1662   if mplib_shade_ty > mplib_shade_dy :
1663     mplib_shade_ny := i + 1 ;
1664     mplib_shade_ly := ypart point i of p ;
1665     mplib_shade_dy := mplib_shade_ty ;
1666   fi ;
1667 endfor ;
1668 enddef;
1669 vardef mplib_max_radius(expr p) =
1670   max (
1671     (xpart center p - xpart llcorner p) ++ (ypart center p - ypart llcorner p),
1672     (xpart center p - xpart ulcorner p) ++ (ypart ulcorner p - ypart center p),
1673     (xpart lrcorner p - xpart center p) ++ (ypart center p - ypart lrcorner p),
1674     (xpart urcorner p - xpart center p) ++ (ypart urcorner p - ypart center p)
1675   )
1676 enddef;
1677 def withshadingstep (text t) =
1678   hide(mplib_shade_step := mplib_shade_step + 1 ;)
1679   withprescript "sh_step=" & decimal mplib_shade_step
1680   t
1681 enddef;
1682 def withshadingradius expr a =
1683   withprescript "sh_radius_a=" & decimal (xpart a)
1684   withprescript "sh_radius_b=" & decimal (ypart a)
1685 enddef;
1686 def withshadingorigin expr a =
1687   withprescript "sh_center_a=" & ddecimal a
1688   withprescript "sh_center_b=" & ddecimal a
1689 enddef;
1690 def withshadingvector expr a =
1691   withprescript "sh_center_a=" & ddecimal (point xpart a of mplib_shade_path)
1692   withprescript "sh_center_b=" & ddecimal (point ypart a of mplib_shade_path)
1693 enddef;
1694 def withshadingdirection expr a =
1695   withprescript "sh_center_a=" & ddecimal (point xpart a of boundingbox(mplib_shade_path))
1696   withprescript "sh_center_b=" & ddecimal (point ypart a of boundingbox(mplib_shade_path))
1697 enddef;
1698 def withshadingtransform expr a =
1699   withprescript "sh_transform=" & a
1700 enddef;
1701 def withshadingcenter expr a =
1702   withprescript "sh_center_a=" & ddecimal (
1703     center mplib_shade_path shifted (
1704       xpart a * xpart (lrcorner mplib_shade_path - llcorner mplib_shade_path)/2,
1705       ypart a * ypart (urcorner mplib_shade_path - lrcorner mplib_shade_path)/2
1706     )

```

```

1707 )
1708 enddef;
1709 def withshadingdomain expr d =
1710   withprescript "sh_domain=" & ddecimal d
1711 enddef;
1712 def withshadingfactor expr f =
1713   withprescript "sh_factor=" & decimal f
1714 enddef;
1715 def withshadingfraction expr a =
1716   if mplib_shade_step > 0 :
1717     withprescript "sh_fraction_" & decimal mplib_shade_step & "=" & decimal a
1718   fi
1719 enddef;
1720 def withshadingcolors (expr a, b) =
1721   if mplib_shade_step > 0 :
1722     withprescript "sh_color=into"
1723     withprescript "sh_color_a_" & decimal mplib_shade_step & "=" & colordecimals a
1724     withprescript "sh_color_b_" & decimal mplib_shade_step & "=" & colordecimals b
1725   else :
1726     withprescript "sh_color=into"
1727     withprescript "sh_color_a=" & colordecimals a
1728     withprescript "sh_color_b=" & colordecimals b
1729   fi
1730 enddef;
1731 def withshadingstroke expr a =
1732   withprescript "sh_stroking=" & a
1733 enddef;
1734 def mpliblength primary t =
1735   runscript("return utf8.len[==[" & t & "]==]")
1736 enddef;
1737 def mplibsubstring expr p of t =
1738   runscript("return luamplib.unicodesubstring([==[" & t & "]==],",
1739     & decimal xpart p & ",",
1740     & decimal ypart p & ")")
1741 enddef;
1742 def mlibuclength primary t =
1743   runscript("return #luamplib.getunicodegraphemes[==[" & t & "]==]")
1744 enddef;
1745 def mlibucsubstring expr p of t =
1746   runscript("return luamplib.unicodesubstring([==[" & t & "]==],",
1747     & decimal xpart p & ",",
1748     & decimal ypart p & ",true)")
1749 enddef;
1750 ]],
1751 legacyverbatimtex = [[
1752 def specialVerbatimTeX (text t) = runscript("luamplibprefig{"&t&}") enddef;
1753 def normalVerbatimTeX (text t) = runscript("luamplibinfig{"&t&}") enddef;
1754 let VerbatimTeX = specialVerbatimTeX;
1755 extra_beginfig := extra_beginfig & " let VerbatimTeX = normalVerbatimTeX;"&

```

```

1756 "runscript(" &ditto& "luamplib.in_the_fig=true" &ditto& ");";
1757 extra_endfig := extra_endfig & " let VerbatimTeX = specialVerbatimTeX;"&
1758 "runscript(" &ditto&
1759 "if luamplib.in_the_fig then luamplib.figid=luamplib.figid+1 end "&
1760 "luamplib.in_the_fig=false" &ditto& ");";
1761 ]],
1762 texttextlabel = [[
1763 let luampliboriginalinfont = infont;
1764 primarydef s infont f =
1765   if (s < char 32)
1766     or (s = char 35) % #
1767     or (s = char 36) % $
1768     or (s = char 37) % %
1769     or (s = char 38) % &
1770     or (s = char 92) % \
1771     or (s = char 94) % ^
1772     or (s = char 95) % _
1773     or (s = char 123) % {
1774     or (s = char 125) % }
1775     or (s = char 126) % ~
1776     or (s = char 127) :
1777     s luampliboriginalinfont f
1778   else :
1779     rawtexttext(s)
1780   fi
1781 enddef;
1782 def fontsize expr f =
1783   begingroup
1784     save size; numeric size;
1785     size := mplibdimen("1em");
1786     if size = 0: 10pt else: size fi
1787   endgroup
1788 enddef;
1789 ]],
1790 }
1791

```

process_mplibcode

When \mplibverbatim is enabled, do not expand mplibcode data.

```

1792 luamplib.verbatiminput = false
1793 luamplib.everymplib = setmetatable({ ["" ] = "" },{ __index = function(t) return t[""] end })
1794 luamplib.everyendmplib = setmetatable({ ["" ] = "" },{ __index = function(t) return t[""] end })
1795 function luamplib.process_mplibcode (data, instancename)
1796   texboxes.localid = 4096

```

This is needed for legacy behavior

```

1797 if luamplib.legacyverbatim then
1798   luamplib.figid, tex_code_pre_mplib = 1, {}
1799 end
1800 local everymplib = luamplib.everymplib[instancename]

```

```

1801 local everyendmplib = luamplib.everyendmplib[instancename]
1802 data = format("\n%s\n%s\n%s\n",everymplib, data, everyendmplib)
1803 :gsub("\r","\n")

```

These five lines are needed for mplibverbatim mode.

```

1804 if luamplib.verbatiminput then
1805   data = data:gsub("\mpcolor%+{b{}}", "mplibcolor(\"%1\")")
1806   :gsub("\mpdim%+{b{}}", "mplibdimen(\"%1\")")
1807   :gsub("\mpdim%+(\%a+)", "mplibdimen(\"%1\")")
1808   :gsub(btex_etex, "btex %1 etex ")
1809   :gsub(verbatimtex_etex, "verbatimtex %1 etex;")
1810 else

```

If not mplibverbatim, expand mplibcode data, so that users can use \TeX codes in it. It has turned out that no comment sign is allowed. However, we do not expand btex ... etex, verbatimtex ... etex, and string expressions.

```

1811   local t = { } -- to store btex, verbatimtex, string
1812   data = data:gsub(btex_etex, function(str)
1813     t[#t+1] = str
1814     return format("btex \\unexpanded{!l!u!a!s!m!p!l!} etex ", #t) -- space
1815   end)
1816   :gsub(verbatimtex_etex, function(str)
1817     t[#t+1] = str
1818     return format("verbatimtex \\unexpanded{!l!u!a!s!m!p!l!} etex;", #t) -- semicolon
1819   end)
1820   :gsub("'", function(str)
1821     t[#t+1] = str
1822     return format("\\unexpanded{!l!u!a!s!m!p!l!}", #t)
1823   end)
1824   :gsub("\\%", "\\0PerCent\0")
1825   :gsub("%%.-\n", "\n")
1826   :gsub("%zPerCent%z", "\\%")
1827   run_tex_code(format("\mplibtmptoks\\expandafter{\\expanded{%s}}",data))
1828   data = texgettoks"mplibtmptoks"

```

Next line to address issue #55

```

1829   :gsub("##", "#")
1830   :gsub("!l!u!a!(%d+)!m!p!l!", function(str) return t[tonumber(str)] or str end)
1831 end
1832 process(data, instancename)
1833 end
1834

```

pdf literals will be stored in figcontents table, and written to pdf in one go at the end of the flushing figure. Subtable post is for the legacy behavior.

```

1835 local figcontents = { post = { } }
1836 local function put2output(a,...)
1837   figcontents[#figcontents+1] = type(a) == "string" and format(a,...) or a
1838 end
1839 local function pdf_startfigure(n,llx,lly,urx,ury)

```



```

1840 put2output("\mplibstarttoPDF{%f}{%f}{%f}{%f}",llx,lly,urx,ury)
1841 end
1842 local function pdf_stopfigure()
1843 put2output("\mplibstoptoPDF")
1844 end

```

tex.sprint with catcode regime -2, as sometimes # gets doubled in the argument of pdfliteral.

```

1845 local function pdf_literalcode (...)
1846 put2output{ -2, (format(...) :gsub(decimals,rmzeros)) }
1847 end
1848 local start_pdf_code = pdfmode
1849 and function() pdf_literalcode"q" end
1850 or function() put2output"\special{pdf:bcontent}" end
1851 local stop_pdf_code = pdfmode
1852 and function() pdf_literalcode"Q" end
1853 or function() put2output"\special{pdf:econtent}" end
1854

```

Now we process hboxes created from btex ... etex or texttext(...) or TEX(...) etc.

```

1855 local function put_tex_boxes (object,prescript)
1856 local box = prescript.mplibtexboxid:explode":"
1857 local n,tw,th = box[1],tonumber(box[2]),tonumber(box[3])
1858 if n and tw and th then
1859 local op = object.path
1860 local first, second, fourth = op[1], op[2], op[4]
1861 local tx, ty = first.x_coord, first.y_coord
1862 local sx, rx, ry, sy = 1, 0, 0, 1
1863 if tw ~= 0 then
1864 sx = (second.x_coord - tx)/tw
1865 rx = (second.y_coord - ty)/tw
1866 if sx == 0 then sx = 0.00001 end
1867 end
1868 if th ~= 0 then
1869 sy = (fourth.y_coord - ty)/th
1870 ry = (fourth.x_coord - tx)/th
1871 if sy == 0 then sy = 0.00001 end
1872 end
1873 start_pdf_code()
1874 pdf_literalcode("%f %f %f %f %f %f cm",sx,rx,ry,sy,tx,ty)
1875 put2output("\mplibputtextbox{%i}",n)
1876 stop_pdf_code()
1877 end
1878 end
1879

```

Colors

```

1880 local do_preobj_CR
1881 do
1882 local prev_override_color
1883 function do_preobj_CR(object,prescript)

```

```

1884   if object.postscript == "collect" then return end
1885   local override = prescript and prescript.mpliboverridecolor
1886   if override then
1887     if pdfmode then
1888       pdf_literalcode(override)
1889       override = nil
1890     else
1891       put2output("\\special{%s}",override)
1892       prev_override_color = override
1893     end
1894   else
1895     local cs = object.color
1896     if cs and #cs > 0 then
1897       pdf_literalcode(luamplib.colorconverter(cs))
1898       prev_override_color = nil
1899     elseif not pdfmode then
1900       override = prev_override_color
1901       if override then
1902         put2output("\\special{%s}",override)
1903       end
1904     end
1905   end
1906   return override
1907 end
1908 end
1909

```

For transparency, shading, fading, and pattern

```

1910 local pdfmanagement = is_defined'pdfmanagement_add:nnn'
1911 local pdfobjs, pdfetcs = {}, {}
1912 pdfetcs.pgftxtgs = "pgf@sys@addpdfresource@extgs@plain"
1913 pdfetcs.pgfpattern = "pgf@sys@addpdfresource@patterns@plain"
1914 pdfetcs.pgfcolorspace = "pgf@sys@addpdfresource@colorspaces@plain"
1915 local function update_pdfobjs (os, stream)
1916   local key = os
1917   if stream then key = key..stream end
1918   local on = key and pdfobjs[key]
1919   if on then
1920     return on,false
1921   end
1922   if pdfmode then
1923     if stream then
1924       on = pdf.immediateobj("stream",stream,os)
1925     elseif os then
1926       on = pdf.immediateobj(os)
1927     else
1928       on = pdf.reserveobj()
1929     end
1930   else

```

```

1931   on = pdfetcs.cnt or 1
1932   if stream then
1933     textsprint(format("\\special{pdf:stream @mplibpdfobj%s (%s) <<{s}>>}",on,stream,os))
1934   elseif os then
1935     textsprint(format("\\special{pdf:obj @mplibpdfobj%s %s}",on,os))
1936   else
1937     textsprint(format("\\special{pdf:obj @mplibpdfobj%s <<>>}",on))
1938   end
1939   pdfetcs.cnt = on + 1
1940 end
1941 if key then
1942   pdfobjs[key] = on
1943 end
1944 return on,true
1945 end
1946 pdfetcs.resfmt = pdfmode and "%s 0 R" or "@mplibpdfobj%s"
1947 if pdfmode then
1948   pdfetcs.getpagers = pdf.getpagersources or function() return pdf.pagersources end
1949   local getpagers = pdfetcs.getpagers
1950   local setpagers = pdf.setpagersources or function(s) pdf.pagersources = s end
1951   local initialize_resources = function (name)
1952     local tabname = format("%s_res",name)
1953     pdfetcs[tabname] = { }
1954     if luatexbase.callbacktypes.finish_pdffile then -- ltluatex
1955       local obj = pdf.reserveobj()
1956       setpagers(format("%s/%s %i 0 R", getpagers() or "", name, obj))
1957       luatexbase.add_to_callback("finish_pdffile", function()
1958         pdf.immediateobj(obj, format("<<{s}>>", tableconcat(pdfetcs[tabname])))
1959       end,
1960       format("luamplib.%s.finish_pdffile",name))
1961     end
1962   end
1963   pdfetcs.fallback_update_resources = function (name, res)
1964     local tabname = format("%s_res",name)
1965     if not pdfetcs[tabname] then
1966       initialize_resources(name)
1967     end
1968     if luatexbase.callbacktypes.finish_pdffile then
1969       local t = pdfetcs[tabname]
1970       t[#t+1] = res
1971     else
1972       local tpr, n = getpagers() or "", 0
1973       tpr, n = tpr:gsub(format("/%s<<",name), "%1"..res)
1974       if n == 0 then
1975         tpr = format("%s/%s<<{s}>>", tpr, name, res)
1976       end
1977       setpagers(tpr)
1978     end
1979   end

```

```

1980 else
1981   texsprint {
1982     "\\luamplibatfirstshipout{",
1983     "\\special{pdf:obj @MPlibTr<<>>}",
1984     "\\special{pdf:obj @MPlibSh<<>>}",
1985     "\\special{pdf:obj @MPlibCS<<>>}",
1986     "\\special{pdf:obj @MPlibPt<<>>}}",
1987   }
1988   pdfetcs.resadded = { }
1989   pdfetcs.fallback_update_resources = function (name,res,obj)
1990     texsprint{"\\special{pdf:put ", obj, " <<", res, ">>}" }
1991     if not pdfetcs.resadded[name] then
1992       texsprint{"\\luampliateveryshipout{\\special{pdf:put @resources <</", name, " ", obj, ">>}}"}
1993       pdfetcs.resadded[name] = obj
1994     end
1995   end
1996 end
1997

```

Transparency

```

1998 local function add_extgs_resources (on, new)
1999   local key = format("MPlibTr%s", on)
2000   if new then
2001     local val = format(pdfetcs.resfmt, on)
2002     if pdfmanagement then
2003       texsprint {
2004         "\\csname pdfmanagement_add:nnn\\endcsname{Page/Resources/ExtGState}{", key, "}{" , val, "}"
2005       }
2006     else
2007       local tr = format("/%s %s", key, val)
2008       if is_defined(pdfetcs.pgfextgs) then
2009         texsprint { "\\csname ", pdfetcs.pgfextgs, "\\endcsname{" , tr, "}" }
2010       elseif is_defined"TRP@list" then
2011         texsprint(catat11,{
2012           [[\if@files\immediate\write\@auxout{]],
2013           [[\string\g@addto@macro\string\TRP@list{]],
2014           tr,
2015           [[}]\fi]],
2016         })
2017         if not get_macro"TRP@list":find(tr) then
2018           texsprint(catat11,[[\global\TRP@reruntrue]])
2019         end
2020       else
2021         pdfetcs.fallback_update_resources("ExtGState",tr,"@MPlibTr")
2022       end
2023     end
2024   end
2025   return key
2026 end

```

```

2027
2028 local do_preobj_TR
2029 do
2030   local transparency_modes = {
2031     [0] = "Normal",
2032     "Normal",    "Multiply",    "Screen",    "Overlay",
2033     "SoftLight", "HardLight",   "ColorDodge", "ColorBurn",
2034     "Darken",    "Lighten",     "Difference", "Exclusion",
2035     "Hue",        "Saturation",  "Color",     "Luminosity",
2036     "Compatible",
2037     normal      = "Normal",    multiply    = "Multiply",    screen     = "Screen",
2038     overlay     = "Overlay",   softlight  = "SoftLight",  hardlight  = "HardLight",
2039     colordodge  = "ColorDodge", colorburn  = "ColorBurn",  darken     = "Darken",
2040     lighten     = "Lighten",   difference = "Difference", exclusion   = "Exclusion",
2041     hue         = "Hue",       saturation = "Saturation", color       = "Color",
2042     luminosity  = "Luminosity", compatible  = "Compatible",
2043   }
2044   function do_preobj_TR(object,prescript)
2045     if object.postscript == "collect" then return end
2046     local opaq = prescript and prescript.tr_transparency
2047     if opaq then
2048       local key, on, os, new
2049       local mode = prescript.tr_alternative or 1
2050       mode = transparency_modes[tonumber(mode) or mode:lower()]
2051       if not mode then
2052         mode = prescript.tr_alternative
2053         warn("unsupported blend mode: '%s'", mode)
2054       end
2055       opaq = format("%.3f", opaq) :gsub(decimals,rmzeros)
2056       for i,v in ipairs{ {mode,opaq},{ "Normal",1} } do
2057         os = format("<</BM/%s/ca %s/CA %s/AIS false>>",v[1],v[2],v[2])
2058         on, new = update_pdfobjs(os)
2059         key = add_extgs_resources(on,new)
2060         if i == 1 then
2061           pdf_literalcode("/%s gs",key)
2062         else
2063           return format("/%s gs",key)
2064         end
2065       end
2066     end
2067   end
2068 end
2069

```

Shading with *metafun* format.

```

2070 local function sh_pdfpageresources(shtype,domain,colorspace,ca,cb,coordinates,steps,fractions)
2071   for _,v in ipairs{ca,cb} do
2072     for i,vv in ipairs(v) do
2073       for ii,vvv in ipairs(vv) do

```

```

2074         v[i][ii] = tonumber(vvv) and format("%.3f",vvv) or vvv
2075     end
2076 end
2077 end
2078 local fun2fmt,os = "<</FunctionType 2/Domain[%s]/C0[%s]/C1[%s]/N 1>>"
2079 if steps > 1 then
2080     local list,bounds,encode = { },{ },{ }
2081     for i=1,steps do
2082         if i < steps then
2083             bounds[i] = format("%.3f", fractions[i] or 1)
2084         end
2085         encode[2*i-1] = 0
2086         encode[2*i] = 1
2087         os = fun2fmt:format(domain,tableconcat(ca[i],' '),tableconcat(cb[i],' '))
2088             :gsub(decimals,rmzeros)
2089         list[i] = format(pdfetcs.resfmt, update_pdfobjs(os))
2090     end
2091     os = tableconcat {
2092         "<</FunctionType 3",
2093         format("/Bounds[%s]", tableconcat(bounds,' ')),
2094         format("/Encode[%s]", tableconcat(encode,' ')),
2095         format("/Functions[%s]", tableconcat(list, ' ')),
2096         format("/Domain[%s]>>", domain),
2097     } :gsub(decimals,rmzeros)
2098 else
2099     os = fun2fmt:format(domain,tableconcat(ca[1],' '),tableconcat(cb[1],' '))
2100     :gsub(decimals,rmzeros)
2101 end
2102 local objref = format(pdfetcs.resfmt, update_pdfobjs(os))
2103 os = tableconcat {
2104     format("<</ShadingType %i", shtype),
2105     format("/ColorSpace %s", colorspace),
2106     format("/Function %s", objref),
2107     format("/Coords[%s]", coordinates),
2108     "/Extend[true true]/AntiAlias true>>",
2109 } :gsub(decimals,rmzeros)
2110 local on, new = update_pdfobjs(os)
2111 if new then
2112     local key, val = format("MPlibSh%s", on), format(pdfetcs.resfmt, on)
2113     if pdfmanagement then
2114         texsprint {
2115             "\\csname pdfmanagement_add:nnn\\endcsname{Page/Resources/Shading}{", key, "}{", val, "}"
2116         }
2117     else
2118         local res = format("/%s %s", key, val)
2119         pdfetcs.fallback_update_resources("Shading",res,"@MPlibSh")
2120     end
2121 end
2122 return on

```

```

2123 end
2124
2125 local do_preobj_SH
2126 do
2127   pdfetcs.clrspcs = setmetatable({ }, { __index = function(t,names)
2128     run_tex_code({
2129       [[\color_model_new:nnn]],
2130       format("{mplibcolorspace_%s}", names:gsub(",","_")),
2131       format("{DeviceN}{names={%s}}", names),
2132       [[\edef\mplib@tempa{\pdf_object_ref_last:}]],
2133     }, ccexplat)
2134     local colorspace = get_macro'mplib@tempa'
2135     t[names] = colorspace
2136     return colorspace
2137   end })
2138   local function color_normalize(ca,cb)
2139     if #cb == 1 then
2140       if #ca == 4 then
2141         cb[1], cb[2], cb[3], cb[4] = 0, 0, 0, 1-cb[1]
2142       else -- #ca = 3
2143         cb[1], cb[2], cb[3] = cb[1], cb[1], cb[1]
2144       end
2145     elseif #cb == 3 then -- #ca == 4
2146       cb[1], cb[2], cb[3], cb[4] = 1-cb[1], 1-cb[2], 1-cb[3], 0
2147     end
2148   end
2149   function do_preobj_SH(object, prescript)
2150     local shade_no
2151     local sh_type = prescript and prescript.sh_type
2152     if not sh_type then
2153       return
2154     else
2155       local domain = prescript.sh_domain or "0 1"
2156       local centera = (prescript.sh_center_a or "0 0"):explode()
2157       local centerb = (prescript.sh_center_b or "0 0"):explode()
2158       local transform = prescript.sh_transform == "yes"
2159       local sx,sy,sr,dx,dy = 1,1,1,0,0
2160       if transform then
2161         local first = (prescript.sh_first or "0 0"):explode()
2162         local setx = (prescript.sh_set_x or "0 0"):explode()
2163         local sety = (prescript.sh_set_y or "0 0"):explode()
2164         local x,y = tonumber(setx[1]) or 0, tonumber(sety[1]) or 0
2165         if x ~= 0 and y ~= 0 then
2166           local path = object.path
2167           local path1x = path[1].x_coord
2168           local path1y = path[1].y_coord
2169           local path2x = path[x].x_coord
2170           local path2y = path[y].y_coord
2171           local dxa = path2x - path1x

```

```

2172     local dya = path2y - path1y
2173     local dxb = setx[2] - first[1]
2174     local dyb = sety[2] - first[2]
2175     if dxa ~= 0 and dya ~= 0 and dxb ~= 0 and dyb ~= 0 then
2176         sx = dxa / dxb ; if sx < 0 then sx = - sx end
2177         sy = dya / dyb ; if sy < 0 then sy = - sy end
2178         sr = math.sqrt(sx^2 + sy^2)
2179         dx = path1x - sx*first[1]
2180         dy = path1y - sy*first[2]
2181     end
2182 end
2183 end
2184 local ca, cb, colorspace, steps, fractions
2185 ca = { (prescript.sh_color_a_1 or prescript.sh_color_a or "0"):explode":" }
2186 cb = { (prescript.sh_color_b_1 or prescript.sh_color_b or "1"):explode":" }
2187 steps = tonumber(prescript.sh_step) or 1
2188 if steps > 1 then
2189     fractions = { prescript.sh_fraction_1 or 0 }
2190     for i=2,steps do
2191         fractions[i] = prescript[format("sh_fraction_%i",i)] or (i/steps)
2192         ca[i] = (prescript[format("sh_color_a_%i",i)] or "0"):explode":"
2193         cb[i] = (prescript[format("sh_color_b_%i",i)] or "1"):explode":"
2194     end
2195 end
2196 if prescript.mplib_spotcolor then
2197     ca, cb = { }, { }
2198     local names, pos, objref = { }, -1, ""
2199     local script = object.prescript:explode"\13+"
2200     for i=#script,1,-1 do
2201         if script[i]:find"mplib_spotcolor" then
2202             local t, name, value = script[i]:explode"="[2]:explode":"
2203             value, objref, name = t[1], t[2], t[3]
2204             if not names[name] then
2205                 pos = pos+1
2206                 names[name] = pos
2207                 names[#names+1] = name
2208             end
2209             t = { }
2210             for j=1,names[name] do t[#t+1] = 0 end
2211             t[#t+1] = value
2212             tableinsert(#ca == #cb and ca or cb, t)
2213         end
2214     end
2215     for _,t in ipairs{ca,cb} do
2216         for _,tt in ipairs(t) do
2217             for i=1,#names-#tt do tt[#tt+1] = 0 end
2218         end
2219     end
2220     if #names == 1 then

```



```

2221     colorspace = objref
2222   else
2223     colorspace = pdfetcs.clrspcs[ tableconcat(names,"") ]
2224   end
2225   else
2226     local model = 0
2227     for _,t in ipairs{ca,cb} do
2228       for _,tt in ipairs(t) do
2229         model = model > #tt and model or #tt
2230       end
2231     end
2232     for _,t in ipairs{ca,cb} do
2233       for _,tt in ipairs(t) do
2234         if #tt < model then
2235           color_normalize(model == 4 and {1,1,1,1} or {1,1,1},tt)
2236         end
2237       end
2238     end
2239     colorspace = model == 4 and "/DeviceCMYK"
2240                or model == 3 and "/DeviceRGB"
2241                or model == 1 and "/DeviceGray"
2242                or err"unknown color model"
2243   end
2244   if sh_type == "linear" then
2245     local coordinates = format("%f %f %f %f",
2246                               dx + sx*centera[1], dy + sy*centera[2],
2247                               dx + sx*centerb[1], dy + sy*centerb[2])
2248     shade_no = sh_pdfpageresources(2,domain,colorspace,ca,cb,coordinates,steps,fractions)
2249   elseif sh_type == "circular" then
2250     local factor = prescript.sh_factor or 1
2251     local radiusa = factor * prescript.sh_radius_a
2252     local radiusb = factor * prescript.sh_radius_b
2253     local coordinates = format("%f %f %f %f %f %f",
2254                               dx + sx*centera[1], dy + sy*centera[2], sr*radiusa,
2255                               dx + sx*centerb[1], dy + sy*centerb[2], sr*radiusb)
2256     shade_no = sh_pdfpageresources(3,domain,colorspace,ca,cb,coordinates,steps,fractions)
2257   else
2258     err"unknown shading type"
2259   end
2260 end
2261 return shade_no, prescript.sh_stroking == "yes"
2262 end
2263 end
2264

```

Shading Patterns: we can apply shading to textual pictures as well as paths.

```

2265 if not pdfmode then
2266   pdfetcs.patternresources = {}
2267 end

```

```

2268 local function add_pattern_resources (key, val)
2269   if pdfmanagement then
2270     texsprint {
2271       "\\csname pdfmanagement_add:nnn\\endcsname{Page/Resources/Pattern}{", key, "}{" , val, "}"
2272     }
2273   else
2274     local res = format("/%s %s", key, val)
2275     if is_defined(pdfetcs.pgfpattern) then
2276       texsprint { "\\csname ", pdfetcs.pgfpattern, "\\endcsname{" , res, "}" }
2277     else
2278       pdfetcs.fallback_update_resources("Pattern",res,"@MPLibPt")
2279       if not pdfmode then
2280         tableinsert(pdfetcs.patternresources, res) -- for gather_resources()
2281       end
2282     end
2283   end
2284 end
2285 function luamplib.dolatelua (on, os)
2286   local h, v = pdf.getpos()
2287   h = format("%f", h/factor) :gsub(decimals,rmzeros)
2288   v = format("%f", v/factor) :gsub(decimals,rmzeros)
2289   if pdfmode then
2290     pdf.obj(on, format("<<%s/Matrix[1 0 0 1 %s %s]>>", os, h, v))
2291     pdf.refobj(on)
2292   else
2293     local shift = os:explode()
2294     if tonumber(h) ~= tonumber(shift[1]) or tonumber(v) ~= tonumber(shift[2]) then
2295       warn([[Add 'withprescript "sh_matrixshift=%s %s"' to the picture shading]], h, v)
2296     end
2297   end
2298 end
2299 local function do_preobj_shading (object, prescript)
2300   if not prescript or not prescript.sh_operand_type then return end
2301   local on = do_preobj_SH(object, prescript)
2302   local os = format("/PatternType 2/Shading %s", format(pdfetcs.resfmt, on))
2303   on = update_pdfobjs()
2304   if pdfmode then
2305     put2output(tableconcat{ "\\latelua{ luamplib.dolatelua(",on,",[",os,"])" }})
2306   else

```

Why @xpos @ypos do not work properly???

Anyway, this seems to be needed for proper functioning:

```

\pagewidth=\paperwidth
\pageheight=\paperheight
\special{papersize=\the\paperwidth,\the\paperheight}

```

```

2307   if is_defined"RecordProperties" then
2308     put2output(tableconcat{
2309       "\\csname tex_savepos:D\\endcsname\\RecordProperties{luamplib/getpos/",on,"}{xpos,ypos}\z

```

```

2310     \special{pdf:put @mplibpdfobj",on," <<",os,"/Matrix[1 0 0 1 \z
2311     \csname dim_to_decimal_in_bp:n\endcsname{\RefProperty{luamplib/getpos/" ,on,"}{xpos}sp} \z
2312     \csname dim_to_decimal_in_bp:n\endcsname{\RefProperty{luamplib/getpos/" ,on,"}{ypos}sp}\z
2313     ]>>}"
2314   })
2315   else
2316     local shift = prescript.sh_matrixshift or "0 0"
2317     texsprint{ "\special{pdf:put @mplibpdfobj",on," <<",os,"/Matrix[1 0 0 1 ",shift,"]>>}" }
2318     put2output(tableconcat{ "\latelua{ luamplib.dolatelua(",on,",[[" ,shift,"]] )}" })
2319   end
2320 end
2321 local key, val = format("MPlibPt%s", on), format(pdfetcs.resfmt, on)
2322 add_pattern_resources(key,val)
2323 pdf_literalcode("/Pattern cs/%s scn", key)

```

To avoid possible double execution, once by Pattern gs, once by Sh operator.

```

2324 prescript.sh_type = nil
2325 end
2326

```

Tiling Patterns

```

2327 pdfetcs.patterns = { }
2328 local function gather_resources (optres)
2329   local t, do_pattern = { }, not optres
2330   local names = {"ExtGState","ColorSpace","Shading"}
2331   if do_pattern then
2332     names[#names+1] = "Pattern"
2333   end
2334   if pdfmode then
2335     if pdfmanagement then
2336       for _,v in ipairs(names) do
2337         if ltx.__pdf.Page.Resources[v] then
2338           t[#t+1] = format("/%s %s 0 R", v, ltx.pdf.object_id("__pdf/Page/Resources/"..v))
2339         end
2340       end
2341     else
2342       local res = pdfetcs.getpageres() or ""
2343       run_tex_code[["\mplibtmptoks\expandafter{\the\pdfvariable pageresources}]]
2344       res = res .. texgettoks'mplibtmptoks'
2345       if do_pattern then return res end
2346       res = res:explode"/+"
2347       for _,v in ipairs(res) do
2348         v = v:match"^%s*(.)%s*$"
2349         if not v:find"Pattern" and not optres:find(v) then
2350           t[#t+1] = "/" .. v
2351         end
2352       end
2353     end
2354   else
2355     if pdfmanagement then

```

```

2356     for _,v in ipairs(names) do
2357         run_tex_code ({
2358             "\\mplibmptoks\\expanded{{" ,
2359             "\\pdfdict_if_empty:nF{g__pdf_Core/Page/Resources/" , v, "}" ,
2360             "{/" , v, " \\pdf_object_ref:n{__pdf/Page/Resources/" , v, "}}}" ,
2361             },ccexplat)
2362         t[#t+1] = texgettoks'mplibmptoks'
2363     end
2364 elseif is_defined(pdfetcs.pgfgextgs) then
2365     run_tex_code ({
2366         "\\mplibmptoks\\expanded{{" ,
2367         "\\ifpgf@sys@pdf@extgs@exists /ExtGState @pgfgextgs\\fi" ,
2368         "\\ifpgf@sys@pdf@colorspaces@exists /ColorSpace @pgfcolorspaces\\fi" ,
2369         do_pattern and "\\ifpgf@sys@pdf@patterns@exists /Pattern @pgfpatterns \\fi" or "" ,
2370         "}" ,
2371     }, catat11)
2372     t[#t+1] = texgettoks'mplibmptoks'
2373     if pdfetcs.resadded.Shading then
2374         t[#t+1] = format("/Shading %s" , pdfetcs.resadded.Shading)
2375     end
2376 else
2377     for _,v in ipairs(names) do
2378         local vv = pdfetcs.resadded[v]
2379         if vv then
2380             t[#t+1] = format("/%s %s" , v, vv)
2381         end
2382     end
2383 end
2384 end
2385 if do_pattern then return tableconcat(t) end
2386 -- get pattern resources
2387 local mytoks
2388 if pdfmanagement then
2389     run_tex_code ({
2390         "\\mplibmptoks\\expanded{{" ,
2391         "\\pdfdict_if_empty:nF{g__pdf_Core/Page/Resources/Pattern}" ,
2392         "\\pdfdict_use:n{g__pdf_Core/Page/Resources/Pattern}}}" , "}" ,
2393     },ccexplat)
2394     mytoks = texgettoks'mplibmptoks'
2395     if not pdfmode then
2396         mytoks = mytoks:gsub("\\str_convert_pdfname:n%s*{(.-)}" , "%1") -- why not expanded?
2397     end
2398 elseif is_defined(pdfetcs.pgfgextgs) then
2399     if pdfmode then
2400         mytoks = get_macro"pgf@sys@pgf@resource@list@patterns"
2401     else
2402         local tt, abc = {}, get_macro"pgfutil@abc" or ""
2403         for v in abc:gmatch"@pgfpatterns%s*<<(.-)>>" do
2404             tt[#tt+1] = v

```

```

2405     end
2406     mytoks = tableconcat(tt)
2407     end
2408 else
2409     local tt = pdfmode and pdfetcs.Pattern_res or pdfetcs.patternresources
2410     mytoks = tt and tableconcat(tt)
2411 end
2412 if mytoks and mytoks ~= "" then
2413     t[#t+1] = format("/Pattern<<%s>>",mytoks)
2414 end
2415 return tableconcat(t)
2416 end
2417 function luamplib.registerpattern ( boxid, name, opts )
2418     local box = texgetbox(boxid)
2419     local wd = format("%.3f",box.width/factor)
2420     local hd = format("%.3f",(box.height+box.depth)/factor)
2421     info("w/h/d of pattern '%s': %s 0", name, format("%s %s",wd, hd):gsub(decimals,rmzeros))
2422     if opts.xstep == 0 then opts.xstep = nil end
2423     if opts.ystep == 0 then opts.ystep = nil end
2424     if opts.colored == nil then
2425         opts.colored = opts.coloured
2426         if opts.colored == nil then
2427             opts.colored = true
2428         end
2429     end
2430     if type(opts.matrix) == "table" then opts.matrix = tableconcat(opts.matrix," ") end
2431     if type(opts.bbox) == "table" then opts.bbox = tableconcat(opts.bbox," ") end
2432     if opts.matrix and opts.matrix:find"%a" then
2433         local data = format("mplibtransformmatrix(%s);",opts.matrix)
2434         process(data,"@mplibtransformmatrix")
2435         local t = luamplib.transformmatrix
2436         opts.matrix = format("%f %f %f %f", t[1], t[2], t[3], t[4])
2437         opts.xshift = opts.xshift or format("%f",t[5])
2438         opts.yshift = opts.yshift or format("%f",t[6])
2439     end
2440     local attr = {
2441         "/Type/Pattern",
2442         "/PatternType 1",
2443         format("/PaintType %i", opts.colored and 1 or 2),
2444         "/TilingType 2",
2445         format("/XStep %s", opts.xstep or wd),
2446         format("/YStep %s", opts.ystep or hd),
2447         format("/Matrix[%s %s %s]", opts.matrix or "1 0 0 1", opts.xshift or 0, opts.yshift or 0),
2448     }
2449     local optres = opts.resources or ""
2450     optres = optres .. gather_resources(optres)
2451     local patterns = pdfetcs.patterns
2452     if pdfmode then
2453         if opts.bbox then

```

```

2454     attr[#attr+1] = format("/BBox[%s]", opts.bbox)
2455 end
2456 attr = tableconcat(attr) :gsub(decimals,rmzeros)
2457 local index = tex.saveboxresource(boxid, attr, optres, true, opts.bbox and 4 or 1)
2458 patterns[name] = { id = index, colored = opts.colored }
2459 else
2460     local cnt = #patterns + 1
2461     local objname = "@mplibpattern" .. cnt
2462     local metric = format("bbox %s", opts.bbox or format("0 0 %s %s",wd,hd))
2463     texsprint {
2464         "\\expandafter\\newbox\\csname luamplib.patternbox.", cnt, "\\endcsname",
2465         "\\global\\setbox\\csname luamplib.patternbox.", cnt, "\\endcsname",
2466         "\\hbox{\\unhbox ", boxid, "}\\luamplibatnextshipout{",
2467         "\\special{pdf:bcontent}",
2468         "\\special{pdf:bxobj ", objname, " ", metric, "}",
2469         "\\raise\\dp\\csname luamplib.patternbox.", cnt, "\\endcsname",
2470         "\\box\\csname luamplib.patternbox.", cnt, "\\endcsname",
2471         "\\special{pdf:put @resources <<", optres, ">>}",
2472         "\\special{pdf:exobj <<", tableconcat(attr), ">>}",
2473         "\\special{pdf:econtent}}",
2474     }
2475     patterns[cnt] = objname
2476     patterns[name] = { id = cnt, colored = opts.colored }
2477 end
2478 end
2479
2480 local do_preobj_PAT
2481 do
2482     local function pattern_colorspace (cs)
2483         local on, new = update_pdfobjs(format("[Pattern %s]", cs))
2484         if new then
2485             local key, val = format("MPLibCS%i",on), format(pdfetcs.resfmt,on)
2486             if pdfmanagement then
2487                 texsprint {
2488                     "\\csname pdfmanagement_add:nnn\\endcsname{Page/Resources/ColorSpace}{", key, "}{", val, "}"
2489                 }
2490             else
2491                 local res = format("/%s %s", key, val)
2492                 if is_defined(pdfetcs.pgfcolorspace) then
2493                     texsprint { "\\csname ", pdfetcs.pgfcolorspace, "\\endcsname{", res, "}" }
2494                 else
2495                     pdfetcs.fallback_update_resources("ColorSpace",res,"@MPLibCS")
2496                 end
2497             end
2498         end
2499         return on
2500     end
2501     function do_preobj_PAT(object, prescript)
2502         local name = prescript and prescript.mplibpattern

```

```

2503     if not name then return end
2504     local patterns = pdfetcs.patterns
2505     local patt = patterns[name]
2506     local index = patt and patt.id or err("cannot get pattern object '%s'", name)
2507     local key = format("MPLibPt%s",index)
2508     if patt.colored then
2509         pdf_literalcode("/Pattern cs /%s scn", key)
2510     else
2511         local color = prescript.mpliboverridecolor
2512         if not color then
2513             local t = object.color
2514             color = t and #t>0 and luamplib.colorconverter(t)
2515         end
2516         if not color then return end
2517         local cs
2518         if color:find" cs " or color:find"@pdf.obj" then
2519             local t = color:explode()
2520             if pdfmode then
2521                 cs = format("%s 0 R", ltx.pdf.object_id( t[1]:sub(2,-1) ))
2522                 color = t[3]
2523             else
2524                 cs = t[2]
2525                 color = t[3]:match"%[(.+)%"
2526             end
2527         else
2528             local t = colorsplit(color)
2529             cs = #t == 4 and "/DeviceCMYK" or #t == 3 and "/DeviceRGB" or "/DeviceGray"
2530             color = tableconcat(t, " ")
2531         end
2532         pdf_literalcode("/MPLibCS%i cs %s /%s scn", pattern_colorspace(cs), color, key)
2533     end
2534     if not patt.done then
2535         local val = pdfmode and format("%s 0 R",index) or patterns[index]
2536         add_pattern_resources(key,val)
2537     end
2538     patt.done = true
2539 end
2540 end
2541

```

Fading

```

2542 pdfetcs.fading = { }
2543 local function do_preobj_FADE (object, prescript)
2544     local fd_type = prescript and prescript.mplibfadetype
2545     local fd_stop = prescript and prescript.mplibfadestate
2546     if not fd_type then
2547         return fd_stop -- returns "stop" (if picture) or nil
2548     end
2549     local bbox = prescript.mplibfadebbox:explode":""

```

```

2550 local dx, dy = -bbox[1], -bbox[2]
2551 local vec = prescript.mplibfadevector; vec = vec and vec:explode":"
2552 if not vec then
2553   if fd_type == "linear" then
2554     vec = {bbox[1], bbox[2], bbox[3], bbox[2]} -- left to right
2555   else
2556     local centerx, centery = (bbox[1]+bbox[3])/2, (bbox[2]+bbox[4])/2
2557     vec = {centerx, centery, centerx, centery} -- center for both circles
2558   end
2559 end
2560 local coords = { vec[1]+dx, vec[2]+dy, vec[3]+dx, vec[4]+dy }
2561 if fd_type == "linear" then
2562   coords = format("%f %f %f %f", tableunpack(coords))
2563 elseif fd_type == "circular" then
2564   local width, height = bbox[3]-bbox[1], bbox[4]-bbox[2]
2565   local radius = (prescript.mplibfaderadius or "0"..math.sqrt(width^2+height^2)/2):explode":"
2566   tableinsert(coords, 3, radius[1])
2567   tableinsert(coords, radius[2])
2568   coords = format("%f %f %f %f %f %f", tableunpack(coords))
2569 else
2570   err("unknown fading method '%s'", fd_type)
2571 end
2572 fd_type = fd_type == "linear" and 2 or 3
2573 local opaq = (prescript.mplibfadeopacity or "1:0"):explode":"
2574 local on, os, new
2575 on = sh_pdfpageresources(fd_type, "0 1", "/DeviceGray", {{opaq[1]}}, {{opaq[2]}}, coords, 1)
2576 os = format("<</PatternType 2/Shading %s>>", format(pdfetcs.resfmt, on))
2577 on = update_pdfobjs(os)
2578 bbox = format("0 0 %f %f", bbox[3]+dx, bbox[4]+dy)
2579 local streamtext = format("q /Pattern cs/MPLibFd%s scn %s re f Q", on, bbox)
2580 :gsub(decimals,rmzeros)
2581 os = format("<</Pattern<</MPLibFd%s %s>>>>", on, format(pdfetcs.resfmt, on))
2582 on = update_pdfobjs(os)
2583 local resources = format(pdfetcs.resfmt, on)
2584 on = update_pdfobjs("<</S/Transparency/CS/DeviceGray>>")
2585 local attr = tableconcat{
2586   "/Subtype/Form",
2587   "/BBox[" .. bbox .. "]",
2588   "/Matrix[1 0 0 1 " .. format("%f %f", -dx,-dy) .. "]",
2589   "/Resources " .. resources,
2590   "/Group " .. format(pdfetcs.resfmt, on),
2591 } :gsub(decimals,rmzeros)
2592 on = update_pdfobjs(attr, streamtext)
2593 os = "<</SMask<</S/Luminosity/G " .. format(pdfetcs.resfmt, on) .. ">>>>"
2594 on, new = update_pdfobjs(os)
2595 local key = add_extgs_resources(on,new)
2596 start_pdf_code()
2597 pdf_literalcode("/%s gs", key)
2598 if fd_stop then return "standalone" end

```



```

2599 return "start"
2600 end
2601

```

Transparency Group

```

2602 pdfetcs.tr_group = { shifts = { } }
2603 luamplib.trgroupshifts = pdfetcs.tr_group.shifts
2604 local function do_preobj_GRP (object, prescript)
2605   local grstate = prescript and prescript.gr_state
2606   if not grstate then return end
2607   local trgroup = pdfetcs.tr_group
2608   if grstate == "start" then
2609     trgroup.name = prescript.mplibgroupname or "lastmplibgroup"
2610     trgroup.isolated, trgroup.knockout = false, false
2611     for _,v in ipairs(prescript.gr_type:explode",+") do
2612       trgroup[v] = true
2613     end
2614     trgroup.bbox = prescript.mplibgroupbbox:explode":"
2615     put2output[["\begingroup\setbox\mplibscratchbox\hbox\bgroup\luamplibtagasgroupset]]
2616   elseif grstate == "stop" then
2617     local llx,lly,urx,ury = tableunpack(trgroup.bbox)
2618     put2output(tableconcat{
2619       "\\egroup",
2620       format("\\wd\mplibscratchbox %fbp", urx-llx),
2621       format("\\ht\mplibscratchbox %fbp", ury-lly),
2622       "\\dp\mplibscratchbox 0pt",
2623     })
2624     local grattr = format("/Group<</S/Transparency/I %s/K %s>>",trgroup.isolated,trgroup.knockout)
2625     local res = gather_resources()
2626     local bbox = format("%f %f %f %f", llx,lly,urx,ury) :gsub(decimals,rmzeros)
2627     if pdfmode then
2628       put2output(tableconcat{
2629         "\\saveboxresource type 2 attr{/Type/XObject/Subtype/Form/FormType 1",
2630         "/BBox[" .. bbox .. "], grattr, "} resources{" .. res .. "}" .. "\\mplibscratchbox",
2631         "\\luamplibtagasgroupput{" .. trgroup.name .. "}" ..,
2632         "[\setbox\mplibscratchbox\hbox{\useboxresource\lastsavedboxresourceindex}]]",
2633         "[\wd\mplibscratchbox 0pt\ht\mplibscratchbox 0pt\dp\mplibscratchbox 0pt]",
2634         "[\box\mplibscratchbox]",
2635         "}" .. "\\endgroup",
2636         "\\expandafter\\xdef\\csname luamplib.group.", trgroup.name, "\\endsname{" ..,
2637         "\\setbox\\mplibscratchbox\\hbox{\\hskip",-llx,"bp\\raise",-lly,"bp\\hbox{" ..,
2638         "\\useboxresource \\the\\lastsavedboxresourceindex",
2639         "}}\\wd\\mplibscratchbox",urx-llx,"bp\\ht\\mplibscratchbox",ury-lly,"bp",
2640         "\\box\\mplibscratchbox}",
2641       })
2642     else
2643       trgroup.cnt = (trgroup.cnt or 0) + 1
2644       local objname = format("@mplibtrgr%s", trgroup.cnt)
2645       put2output(tableconcat{

```

```

2646     "\\special{pdf:bxobj ", objname, " bbox ", bbox, "}",
2647     "\\unhbox\\mplibscratchbox",
2648     "\\special{pdf:put @resources <<", res, ">>}",
2649     "\\special{pdf:exobj <<", grattr, ">>}",
2650     "\\luamplibtagasgroupput{", trgroup.name, "}{",
2651     "\\special{pdf:uxobj ", objname, "}",
2652     "}"\\endgroup",
2653 })
2654 token.set_macro("luamplib.group.."trgroup.name, tableconcat{
2655     "\\setbox\\mplibscratchbox\\hbox{\\hskip", -llx, "bp\\raise", -lly, "bp\\hbox{",
2656     "\\special{pdf:uxobj ", objname, "}",
2657     "}}\\wd\\mplibscratchbox", urx-llx, "bp\\ht\\mplibscratchbox", ury-lly, "bp",
2658     "\\box\\mplibscratchbox",
2659     }, "global")
2660 end
2661 trgroup.shifts[trgroup.name] = { llx, lly }
2662 end
2663 return grstate
2664 end
2665 function luamplib.registergroup (boxid, name, opts)
2666 local box = texgetbox(boxid)
2667 local wd, ht, dp = node.getwhd(box)
2668 local res = (opts.resources or "") .. gather_resources()
2669 local attr = { "/Type/XObject/Subtype/Form/FormType 1" }
2670 if type(opts.matrix) == "table" then opts.matrix = tableconcat(opts.matrix, " ") end
2671 if type(opts.bbox) == "table" then opts.bbox = tableconcat(opts.bbox, " ") end
2672 if opts.matrix and opts.matrix:find"%a" then
2673     local data = format("mplibtransformmatrix(%s);", opts.matrix)
2674     process(data, "@mplibtransformmatrix")
2675     opts.matrix = format("%f %f %f %f %f %f", tableunpack(luamplib.transformmatrix))
2676 end
2677 local grtype = 3
2678 if opts.bbox then
2679     attr[#attr+1] = format("/BBox[%s]", opts.bbox)
2680     grtype = 2
2681 end
2682 if opts.matrix then
2683     attr[#attr+1] = format("/Matrix[%s]", opts.matrix)
2684     grtype = opts.bbox and 4 or 1
2685 end
2686 if opts.asgroup then
2687     local t = { isolated = false, knockout = false }
2688     for _, v in ipairs(opts.asgroup:explode, "+") do t[v] = true end
2689     attr[#attr+1] = format("/Group<</S/Transparency/I %s/K %s>>", t.isolated, t.knockout)
2690 end
2691 local trgroup = pdfetcs.tr_group
2692 trgroup.shifts[name] = { get_macro'MPl1x', get_macro'MPl1y' }
2693 local whd
2694 if pdfmode then

```

```

2695 attr = tableconcat(attr) :gsub(decimals,rmzeros)
2696 local index = tex.saveboxresource(boxid, attr, res, true, grtype)
2697 token.set_macro("luamplib.group.."name, tableconcat{
2698   "\\useboxresource ", index,
2699   }, "global")
2700 whd = format("%.3f %.3f 0", wd/factor, (ht+dp)/factor) :gsub(decimals,rmzeros)
2701 else
2702   trgroup.cnt = (trgroup.cnt or 0) + 1
2703   local objname = format("@mplibtrgr%s", trgroup.cnt)
2704   texsprint {
2705     "\\expandafter\\newbox\\csname luamplib.groupbox.", trgroup.cnt, "\\endcsname",
2706     "\\global\\setbox\\csname luamplib.groupbox.", trgroup.cnt, "\\endcsname",
2707     "\\hbox{\\unhbox ", boxid, "}\\luamplibatnextshipout{",
2708     "\\special{pdf:bcontent}",
2709     "\\special{pdf:bxobj ", objname, " width ", wd, "sp height ", ht, "sp depth ", dp, "sp}",
2710     "\\unhbox\\csname luamplib.groupbox.", trgroup.cnt, "\\endcsname",
2711     "\\special{pdf:put @resources <<", res, ">>}",
2712     "\\special{pdf:exobj <<", tableconcat(attr), ">>}",
2713     "\\special{pdf:econtent}}",
2714   }
2715   token.set_macro("luamplib.group.."name, tableconcat{
2716     "\\setbox\\mplibscratchbox\\hbox{\\special{pdf:uxobj ", objname, "}}",
2717     "\\wd\\mplibscratchbox ", wd, "sp",
2718     "\\ht\\mplibscratchbox ", ht, "sp",
2719     "\\dp\\mplibscratchbox ", dp, "sp",
2720     "\\box\\mplibscratchbox",
2721   }, "global")
2722   whd = format("%.3f %.3f %.3f", wd/factor, ht/factor, dp/factor) :gsub(decimals,rmzeros)
2723 end
2724 info("w/h/d of group '%s': %s", name, whd)
2725 end
2726

```

luamplib.convert: flushing figures

```

2727 do
2728   local function stop_special_effects(fade,opaq,over)
2729     if fade then -- fading
2730       stop_pdf_code()
2731     end
2732     if opaq then -- opacity
2733       pdf_literalcode(opaq)
2734     end
2735     if over then -- color
2736       if over:find"pdf:bc" then
2737         put2output"\\special{pdf:ec}"
2738       else
2739         put2output"\\special{color pop}"
2740       end
2741     end

```

```
2742 end
```

```
2743
```

For parsing prescript materials.

```
2744 local function script2table(s)
```

```
2745   local t = {}
```

```
2746   for _,i in ipairs(s:explode("\13+")) do
```

```
2747     local k,v = i:match("(.-)=(.*)") -- v may contain = or empty.
```

```
2748     if k and v and k ~= "" and not t[k] then
```

```
2749       t[k] = v
```

```
2750     end
```

```
2751   end
```

```
2752   return t
```

```
2753 end
```

```
2754
```

Codes below to insert PDF lieterals are mostly from ConT_EXt general, with small changes when needed.

```
2755 local function pdf_textfigure(font,size,text,width,height,depth)
```

```
2756   text = text:gsub(".",function(c)
```

```
2757     return format("\hbox{\char%i}",string.byte(c)) -- kerning happens in metapost : false
```

```
2758   end)
```

```
2759   put2output("\mplibtexttext{%s}{%f}{%s}{%s}{%s}",font,size,text,0,0)
```

```
2760 end
```

```
2761
```

```
2762 local bend_tolerance = 131/65536
```

```
2763
```

```
2764 local rx, sx, sy, ry, tx, ty, divider = 1, 0, 0, 1, 0, 0, 1
```

```
2765
```

```
2766 local function pen_characteristics(object)
```

```
2767   local t = mplib.pen_info(object)
```

```
2768   rx, ry, sx, sy, tx, ty = t.rx, t.ry, t.sx, t.sy, t.tx, t.ty
```

```
2769   divider = sx*sy - rx*ry
```

```
2770   return not (sx==1 and rx==0 and ry==0 and sy==1 and tx==0 and ty==0), t.width
```

```
2771 end
```

```
2772
```

```
2773 local function concat(px, py) -- no tx, ty here
```

```
2774   return (sy*px-ry*py)/divider,(sx*py-rx*px)/divider
```

```
2775 end
```

```
2776
```

```
2777 local function curved(ith,pth)
```

```
2778   local d = pth.left_x - ith.right_x
```

```
2779   if abs(ith.right_x - ith.x_coord - d) <= bend_tolerance and
```

```
2780     abs(pth.x_coord - pth.left_x - d) <= bend_tolerance then
```

```
2781     d = pth.left_y - ith.right_y
```

```
2782     if abs(ith.right_y - ith.y_coord - d) <= bend_tolerance and
```

```
2783       abs(pth.y_coord - pth.left_y - d) <= bend_tolerance then
```

```
2784       return false
```

```
2785     end
```

```
2786   end
```

```

2787     return true
2788 end
2789
2790 local function flushnormalpath(path,open)
2791     local pth, ith
2792     for i=1,#path do
2793         pth = path[i]
2794         if not ith then
2795             pdf_literalcode("%f %f m",pth.x_coord,pth.y_coord)
2796         elseif curved(ith,pth) then
2797             pdf_literalcode("%f %f %f %f %f %f c",
2798                 ith.right_x,ith.right_y,pth.left_x,pth.left_y,pth.x_coord,pth.y_coord)
2799         else
2800             pdf_literalcode("%f %f l",pth.x_coord,pth.y_coord)
2801         end
2802         ith = pth
2803     end
2804     if not open then
2805         local one = path[1]
2806         if curved(pth,one) then
2807             pdf_literalcode("%f %f %f %f %f %f c",
2808                 pth.right_x,pth.right_y,one.left_x,one.left_y,one.x_coord,one.y_coord )
2809         else
2810             pdf_literalcode("%f %f l",one.x_coord,one.y_coord)
2811         end
2812     elseif #path == 1 then -- special case .. draw point
2813         local one = path[1]
2814         pdf_literalcode("%f %f l",one.x_coord,one.y_coord)
2815     end
2816 end
2817
2818 local function flushconcatpath(path,open)
2819     pdf_literalcode("%f %f %f %f %f %f cm", sx, rx, ry, sy, tx ,ty)
2820     local pth, ith
2821     for i=1,#path do
2822         pth = path[i]
2823         if not ith then
2824             pdf_literalcode("%f %f m",concat(pth.x_coord,pth.y_coord))
2825         elseif curved(ith,pth) then
2826             local a, b = concat(ith.right_x,ith.right_y)
2827             local c, d = concat(pth.left_x,pth.left_y)
2828             pdf_literalcode("%f %f %f %f %f %f c",a,b,c,d,concat(pth.x_coord, pth.y_coord))
2829         else
2830             pdf_literalcode("%f %f l",concat(pth.x_coord, pth.y_coord))
2831         end
2832         ith = pth
2833     end
2834     if not open then
2835         local one = path[1]

```

```

2836     if curved(pth,one) then
2837         local a, b = concat(pth.right_x,pth.right_y)
2838         local c, d = concat(one.left_x,one.left_y)
2839         pdf_literalcode("%f %f %f %f %f %f c",a,b,c,d,concat(one.x_coord, one.y_coord))
2840     else
2841         pdf_literalcode("%f %f l",concat(one.x_coord,one.y_coord))
2842     end
2843 elseif #path == 1 then -- special case .. draw point
2844     local one = path[1]
2845     pdf_literalcode("%f %f l",concat(one.x_coord,one.y_coord))
2846 end
2847 end
2848

```

Finally, flush figures by inserting PDF literals.

```

2849 local function flush (result,flusher)
2850     if result then
2851         local figures = result.fig
2852         if figures then
2853             for f=1, #figures do
2854                 info("flushing figure %s",f)
2855                 local figure = figures[f]
2856                 local objects = figure:objects()
2857                 local fignum = tonumber(figure:filename():match("([%d]+)$") or figure:charcode() or 0)
2858                 local miterlimit, linecap, linejoin, dashed = -1, -1, -1, false
2859                 local bbox = figure:boundingbox()
2860                 local llx, lly, urx, ury = bbox[1], bbox[2], bbox[3], bbox[4] -- faster than unpack
2861                 if urx < llx then

```

luamplib silently ignores this invalid figure for those that do not contain `beginfig ... endfig`.
(issue #70) Original code of ConT_EXt general was:

```

-- invalid
pdf_startfigure(fignum,0,0,0,0)
pdf_stopfigure()

2862     else

```

For legacy behavior, insert ‘pre-fig’ T_EX code here.

```

2863         if tex_code_pre_mplib[f] then
2864             put2output(tex_code_pre_mplib[f])
2865         end
2866         pdf_startfigure(fignum,llx,lly,urx,ury)
2867         start_pdf_code()
2868         if objects then
2869             local savedpath = nil
2870             local savedhtap = nil
2871             for o=1,#objects do
2872                 local object      = objects[o]
2873                 local objecttype  = object.type

```

The following 10 lines are part of `btex...etex` patch. Again, colors are processed at this stage.

```

2874         local prescript      = object.prescript
2875         prescript = prescript and script2table(prescript) -- prescript is now a table
2876         local cr_over = do_preobj_CR(object,prescript) -- color
2877         local tr_opaq = do_preobj_TR(object,prescript) -- opacity
2878         local fading_ = do_preobj_FADE(object,prescript) -- fading
2879         local trgroup = do_preobj_GRP(object,prescript) -- transparency group
2880         local pattern_ = do_preobj_PAT(object,prescript) -- tiling pattern
2881         local shading_ = do_preobj_shading(object,prescript) -- shading pattern
2882         if prescript and prescript.mplibtexboxid then
2883             put_tex_boxes(object,prescript)
2884         elseif objecttype == "start_bounds" or objecttype == "stop_bounds" then --skip
2885             elseif objecttype == "start_clip" then
2886                 local evenodd = not object.istext and object.postscript == "evenodd"
2887                 start_pdf_code()
2888                 flushnormalpath(object.path,false)
2889                 pdf_literalcode(evenodd and "W* n" or "W n")
2890             elseif objecttype == "stop_clip" then
2891                 stop_pdf_code()
2892                 miterlimit, linecap, linejoin, dashed = -1, -1, -1, false
2893             elseif objecttype == "special" then

```

Collect \TeX codes that will be executed after flushing. Legacy behavior.

```

2894         if prescript and prescript.postmplibverbtx then
2895             figcontents.post[#figcontents.post+1] = prescript.postmplibverbtx
2896         end
2897         elseif objecttype == "text" then
2898             local ot = object.transform -- 3,4,5,6,1,2
2899             start_pdf_code()
2900             pdf_literalcode("%f %f %f %f %f %f cm",ot[3],ot[4],ot[5],ot[6],ot[1],ot[2])
2901             pdf_textfigure(object.font,object.dsize,object.text,object.width,object.height,object.depth)
2902             stop_pdf_code()
2903         elseif not trgroup and fading_ ~= "stop" then
2904             local evenodd, collect, both = false, false, false
2905             local postscript = object.postscript
2906             if not object.istext then
2907                 if postscript == "evenodd" then
2908                     evenodd = true
2909                 elseif postscript == "collect" then
2910                     collect = true
2911                 elseif postscript == "both" then
2912                     both = true
2913                 elseif postscript == "eoboth" then
2914                     evenodd = true
2915                     both = true
2916                 end
2917             end
2918             if collect then
2919                 if not savedpath then

```

```

2920         savedpath = { object.path or false }
2921         savedhtap = { object.htap or false }
2922     else
2923         savedpath[#savedpath+1] = object.path or false
2924         savedhtap[#savedhtap+1] = object.htap or false
2925     end
2926 else

```

Removed from ConT_EXt general: color stuff.

```

2927         local ml = object.miterlimit
2928         if ml and ml ~= miterlimit then
2929             miterlimit = ml
2930             pdf_literalcode("%f M",ml)
2931         end
2932         local lj = object.linejoin
2933         if lj and lj ~= linejoin then
2934             linejoin = lj
2935             pdf_literalcode("%i j",lj)
2936         end
2937         local lc = object.linecap
2938         if lc and lc ~= linecap then
2939             linecap = lc
2940             pdf_literalcode("%i J",lc)
2941         end
2942         local dl = object.dash
2943         if dl then
2944             local d = format("[%s] %f d",tableconcat(dl.dashes or {}, " "),dl.offset)
2945             if d ~= dashed then
2946                 dashed = d
2947                 pdf_literalcode(dashed)
2948             end
2949         elseif dashed then
2950             pdf_literalcode("[ ] 0 d")
2951             dashed = false
2952         end
2953         local path = object.path
2954         local transformed, penwidth = false, 1
2955         local open = path and path[1].left_type and path[#path].right_type
2956         local pen = object.pen
2957         if pen then
2958             if pen.type == 'elliptical' then
2959                 transformed, penwidth = pen_characteristics(object) -- boolean, value
2960                 pdf_literalcode("%f w",penwidth)
2961                 if objecttype == 'fill' then
2962                     objecttype = 'both'
2963                 end
2964             else -- calculated by mplib itself
2965                 objecttype = 'fill'
2966             end

```



```

2967 end
Added : shading
2968 local shade_no, shade_stroking = do_preobj_SH(object,prescript) -- shading
2969 if shade_no then
2970     pdf_literalcode"q /Pattern cs"
2971     objecttype = false
2972 end
2973 if transformed then
2974     start_pdf_code()
2975 end
2976 if path then
2977     if savedpath then
2978         for i=1,#savedpath do
2979             local path = savedpath[i]
2980             if transformed then
2981                 flushconcatpath(path,open)
2982             else
2983                 flushnormalpath(path,open)
2984             end
2985         end
2986         savedpath = nil
2987     end
2988     if transformed then
2989         flushconcatpath(path,open)
2990     else
2991         flushnormalpath(path,open)
2992     end
2993     if objecttype == "fill" then
2994         pdf_literalcode(evenodd and "h f*" or "h f")
2995     elseif objecttype == "outline" then
2996         if both then
2997             pdf_literalcode(evenodd and "h B*" or "h B")
2998         else
2999             pdf_literalcode(open and "S" or "h S")
3000         end
3001     elseif objecttype == "both" then
3002         pdf_literalcode(evenodd and "h B*" or "h B")
3003     end
3004 end
3005 if transformed then
3006     stop_pdf_code()
3007 end
3008 local path = object.htap

```

How can we generate an htap object? Please let us know if you have succeeded.

```

3009 if path then
3010     if transformed then
3011         start_pdf_code()
3012     end

```

```

3013         if savedhtap then
3014             for i=1,#savedhtap do
3015                 local path = savedhtap[i]
3016                 if transformed then
3017                     flushconcatpath(path,open)
3018                 else
3019                     flushnormalpath(path,open)
3020                 end
3021             end
3022             savedhtap = nil
3023             evenodd = true
3024         end
3025         if transformed then
3026             flushconcatpath(path,open)
3027         else
3028             flushnormalpath(path,open)
3029         end
3030         if objecttype == "fill" then
3031             pdf_literalcode(evenodd and "h f*" or "h f")
3032         elseif objecttype == "outline" then
3033             pdf_literalcode(open and "S" or "h S")
3034         elseif objecttype == "both" then
3035             pdf_literalcode(evenodd and "h B*" or "h B")
3036         end
3037         if transformed then
3038             stop_pdf_code()
3039         end
3040     end

```

Added to ConT_EXt general: post-object colors and shading stuff. Beware q ... Q scope.

```

3041         if shade_no then -- shading
3042             pdf_literalcode("W%s %s /MPLibSh%s sh Q",
3043                 evenodd and "*" or "", shade_stroking and "s" or "n", shade_no)
3044         end
3045     end
3046 end
3047 if fading_ == "start" then
3048     pdfetcs.fading.specialeffects = {fading_, tr_opaq, cr_over}
3049 elseif trgroup == "start" then
3050     pdfetcs.tr_group.specialeffects = {fading_, tr_opaq, cr_over}
3051 elseif fading_ == "stop" then
3052     local se = pdfetcs.fading.specialeffects
3053     if se then stop_special_effects(se[1], se[2], se[3]) end
3054 elseif trgroup == "stop" then
3055     local se = pdfetcs.tr_group.specialeffects
3056     if se then stop_special_effects(se[1], se[2], se[3]) end
3057 else
3058     stop_special_effects(fading_, tr_opaq, cr_over)
3059 end

```

```

3060         if fading_ or trgroup then -- extgs resetted
3061             miterlimit, linecap, linejoin, dashed = -1, -1, -1, false
3062         end
3063     end
3064 end
3065 stop_pdf_code()
3066 pdf_stopfigure()

```

output collected materials to PDF, plus legacy verbatimtex code.

```

3067     for _,v in ipairs(figcontents) do
3068         if type(v) == "table" then
3069             texsprint"\mplibtoPDF{"; texsprint(v[1], v[2]); texsprint"}"
3070         else
3071             texsprint(v)
3072         end
3073     end
3074     if #figcontents.post > 0 then texsprint(figcontents.post) end
3075     figcontents = { post = { } }
3076 end
3077 end
3078 end
3079 end
3080 end
3081
3082 function luamplib.convert (result, flusher)
3083     flush(result, flusher)
3084     return true -- done
3085 end
3086 end
3087
3088 function luamplib.colorconverter (cr)
3089     local n = #cr
3090     if n == 4 then
3091         local c, m, y, k = cr[1], cr[2], cr[3], cr[4]
3092         return format("%.3f %.3f %.3f %.3f k %.3f %.3f %.3f %.3f K",c,m,y,k,c,m,y,k), "0 g 0 G"
3093     elseif n == 3 then
3094         local r, g, b = cr[1], cr[2], cr[3]
3095         return format("%.3f %.3f %.3f rg %.3f %.3f %.3f RG",r,g,b,r,g,b), "0 g 0 G"
3096     else
3097         local s = cr[1]
3098         return format("%.3f g %.3f G",s,s), "0 g 0 G"
3099     end
3100 end

```

2.2 T_EX package

First we need to load some packages.

```

3101 \ifcsname ProvidesPackage\endcsname

```

We need \LaTeX 2024-06-01 as we use `ltx.pdf.object_id` when `pdfmanagement` is loaded. But as `fp` package does not accept an option, we do not append the date option.

```

3102 \NeedsTeXFormat{LaTeX2e}
3103 \ProvidesPackage{luamplib}
3104 [2026/01/29 v2.38.4 mplib package for LuaTeX]
3105 \fi
3106 \ifdefined\newluafunction\else
3107 \input ltluatex
3108 \fi

```

In DVI mode, a new `XObject` (`mppattern`, `mplibgroup`) must be encapsulated in an `\hbox`. But this should not affect typesetting. So we use Hook mechanism provided by \LaTeX kernel. In Plain, `atbegshi.sty` is loaded.

```

3109 \ifnum\outputmode=0
3110 \ifdefined\AddToHookNext
3111 \def\luamplibatnextshipout{\AddToHookNext{shipout/background}}
3112 \def\luamplibatfirstshipout{\AddToHook{shipout/firstpage}}
3113 \def\luamplibateveryshipout{\AddToHook{shipout/background}}
3114 \else
3115 \input atbegshi.sty
3116 \def\luamplibatnextshipout#1{\AtBeginShipoutNext{\AtBeginShipoutAddToBox{#1}}}
3117 \let\luamplibatfirstshipout\AtBeginShipoutFirst
3118 \def\luamplibateveryshipout#1{\AtBeginShipout{\AtBeginShipoutAddToBox{#1}}}
3119 \fi
3120 \fi

```

Loading of lua code.

```

3121 \directlua{require("luamplib")}

```

legacy commands. Seems we don't need it, but no harm.

```

3122 \ifx\pdfoutput\undefined
3123 \let\pdfoutput\outputmode
3124 \fi
3125 \ifx\pdfliteral\undefined
3126 \protected\def\pdfliteral{\pdfextension literal}
3127 \fi

```

Set the format for METAPOST.

```

3128 \def\mplibsetformat#1{\directlua{luamplib.setformat("#1")}}

```

`luamplib` works in both PDF and DVI mode, but only `DVIPDFMx` is supported currently among a number of DVI tools. So we output a info.

```

3129 \ifnum\pdfoutput>0
3130 \let\mplibtoPDF\pdfliteral
3131 \else
3132 \def\mplibtoPDF#1{\special{pdf:literal direct #1}}
3133 \ifcsname PackageInfo\endcsname
3134 \PackageInfo{luamplib}{only dvipdfmx is supported currently}
3135 \else
3136 \immediate\write-1{luamplib Info: only dvipdfmx is supported currently}

```

```

3137 \fi
3138 \fi

```

To make `mplibcode` typeset always in horizontal mode.

```

3139 \def\mplibforcehmode{\let\prependtomplibbox\leavevmode}
3140 \def\mplibnoforcehmode{\let\prependtomplibbox\relax}
3141 \mplibnoforcehmode

```

Catcode. We want to allow comment sign in `mplibcode`.

```

3142 \def\mplibsetupcatcodes{%
3143   %catcode`\{=12 %catcode`\}=12
3144   \catcode`\#=12 \catcode`\^=12 \catcode`\~=12 \catcode`\_ =12
3145   \catcode`\&=12 \catcode`\$=12 \catcode`\%=12 \catcode`\^^M=12
3146 }

```

Make `btex...etex` box zero-metric.

```

3147 \def\mplibputtextbox#1{\vbox to 0pt{\vss\hbox to 0pt{\raise\dp#1\copy#1\hss}}}
    use Transparency Group
3148 \protected\def\usemplibgroup#1#{\usemplibgroupmain}
3149 \def\usemplibgroupmain#1{%
3150   \prependtomplibbox\hbox dir TLT\bgroup
3151   \csname luamplib.group.#1\endcsname
3152   \egroup
3153 }
3154 \protected\def\mplibgroup#1{%
3155   \begingroup
3156   \def\MPllx{0}\def\MPlly{0}%
3157   \def\mplibgroupname{#1}%
3158   \mplibgroupgetnexttok
3159 }
3160 \def\mplibgroupgetnexttok{\futurelet\nexttok\mplibgroupbranch}
3161 \def\mplibgroupskipspace{\afterassignment\mplibgroupgetnexttok\let\nexttok=}
3162 \def\mplibgroupbranch{%
3163   \ifx [\nexttok
3164     \expandafter\mplibgroupopts
3165   \else
3166     \ifx\mplibsptoken\nexttok
3167       \expandafter\expandafter\expandafter\mplibgroupskipspace
3168     \else
3169       \let\mplibgroupoptions\empty
3170       \expandafter\expandafter\expandafter\mplibgroupmain
3171     \fi
3172   \fi
3173 }
3174 \def\mplibgroupopts[#1]{\def\mplibgroupoptions{#1}\mplibgroupmain}
3175 \def\mplibgroupmain{\setbox\mplibscratchbox\hbox\bgroup\ignorespaces}
3176 \protected\def\endmplibgroup{\egroup
3177   \directlua{ luamplib.registergroup(
3178     \the\mplibscratchbox, '\mplibgroupname', {\mplibgroupoptions}
3179   )}%

```

```

3180 \endgroup
3181 }

Patterns

3182 {\def\:\global\let\mplibsptoken= } \: }
3183 \protected\def\mppattern#1{%
3184 \begingroup
3185 \def\mplibpatternname{#1}%
3186 \mplibpatterngetnexttok
3187 }
3188 \def\mplibpatterngetnexttok{\futurelet\nexttok\mplibpatternbranch}
3189 \def\mplibpatternskipspace{\afterassignment\mplibpatterngetnexttok\let\nexttok= }
3190 \def\mplibpatternbranch{%
3191 \ifx [\nexttok
3192 \expandafter\mplibpatternopts
3193 \else
3194 \ifx\mplibsptoken\nexttok
3195 \expandafter\expandafter\expandafter\mplibpatternskipspace
3196 \else
3197 \let\mplibpatternoptions\empty
3198 \expandafter\expandafter\expandafter\mplibpatternmain
3199 \fi
3200 \fi
3201 }
3202 \def\mplibpatternopts[#1]{%
3203 \def\mplibpatternoptions{#1}%
3204 \mplibpatternmain
3205 }
3206 \def\mplibpatternmain{%
3207 \setbox\mplibscratchbox\hbox\bgroup\ignorespaces
3208 }
3209 \protected\def\endmppattern{%
3210 \egroup
3211 \directlua{ luamplib.registerpattern(
3212 \the\mplibscratchbox, '\mplibpatternname', {\mplibpatternoptions}
3213 )}%
3214 \endgroup
3215 }

simple way to use mplib: \mpfig draw fullcircle scaled 10; \endmpfig

3216 \def\mpfiginstancename{@mpfig}
3217 \protected\def\mpfig{%
3218 \begingroup
3219 \futurelet\nexttok\mplibmpfigbranch
3220 }
3221 \def\mplibmpfigbranch{%
3222 \ifx *\nexttok
3223 \expandafter\mplibprempfig
3224 \else
3225 \ifx [\nexttok

```

```

3226     \expandafter\expandafter\expandafter\mplibgobbleoptsmpfig
3227     \else
3228     \expandafter\expandafter\expandafter\mplibmainmpfig
3229     \fi
3230 \fi
3231 }
3232 \def\mplibgobbleoptsmpfig[#1]{\mplibmainmpfig}
3233 \def\mplibmainmpfig{%
3234     \begingroup
3235     \mplibsetupcatcodes
3236     \mplibdomainmpfig
3237 }
3238 \long\def\mplibdomainmpfig#1\endmpfig{%
3239     \endgroup
3240     \directlua{
3241         local legacy = luamplib.legacyverbatim
3242         local everympfig = luamplib.everymplib["\mpfiginstancename"] or ""
3243         local everyendmpfig = luamplib.everyendmplib["\mpfiginstancename"] or ""
3244         luamplib.legacyverbatim = false
3245         luamplib.everymplib["\mpfiginstancename"] = ""
3246         luamplib.everyendmplib["\mpfiginstancename"] = ""
3247         luamplib.process_mplibcode(
3248             "beginfig(0) \"..everympfig..\" \"..[[[unexpanded{#1}]]]..\" \"..everyendmpfig..\" endfig;",
3249             "\mpfiginstancename")
3250         luamplib.legacyverbatim = legacy
3251         luamplib.everymplib["\mpfiginstancename"] = everympfig
3252         luamplib.everyendmplib["\mpfiginstancename"] = everyendmpfig
3253     }%
3254 \endgroup
3255 }
3256 \def\mplibprempfig#1{%
3257     \begingroup
3258     \mplibsetupcatcodes
3259     \mplibdoprempfig
3260 }
3261 \long\def\mplibdoprempfig#1\endmpfig{%
3262     \endgroup
3263     \directlua{
3264         local legacy = luamplib.legacyverbatim
3265         local everympfig = luamplib.everymplib["\mpfiginstancename"]
3266         local everyendmpfig = luamplib.everyendmplib["\mpfiginstancename"]
3267         luamplib.legacyverbatim = false
3268         luamplib.everymplib["\mpfiginstancename"] = ""
3269         luamplib.everyendmplib["\mpfiginstancename"] = ""
3270         luamplib.process_mplibcode([[[[unexpanded{#1}]]]], "\mpfiginstancename")
3271         luamplib.legacyverbatim = legacy
3272         luamplib.everymplib["\mpfiginstancename"] = everympfig
3273         luamplib.everyendmplib["\mpfiginstancename"] = everyendmpfig
3274     }%

```

```

3275 \endgroup
3276 }
3277 \protected\def\endmpfig{endmpfig}

```

The Plain-specific stuff.

```

3278 \unless\ifcsname ver@luamplib.sty\endcsname
3279 \def\mplibcodegetinstancename[#1]{\xdef\currentmpinstancename{#1}\mplibcodeindeed}
3280 \protected\def\mplibcode{%
3281   \begingroup
3282   \futurelet\nexttok\mplibcodebranch
3283 }
3284 \def\mplibcodebranch{%
3285   \ifx \nexttok
3286     \expandafter\mplibcodegetinstancename
3287   \else
3288     \global\let\currentmpinstancename\empty
3289     \expandafter\mplibcodeindeed
3290   \fi
3291 }
3292 \def\mplibcodeindeed{%
3293   \begingroup
3294   \mplibsetupcatcodes
3295   \mplibdocode
3296 }
3297 \long\def\mplibdocode#1\endmplibcode{%
3298   \endgroup
3299   \directlua{luamplib.process_mplibcode([==[\unexpanded{#1}]==],"\currentmpinstancename")}%
3300   \endgroup
3301 }
3302 \protected\def\endmplibcode{endmplibcode}
3303 \else

```

The L^AT_EX-specific part: a new environment.

```

3304 \newenvironment{mplibcode}[1][{}]{%
3305   \xdef\currentmpinstancename{#1}%
3306   \mplibtmptoks{}\ltxdomplibcode
3307 }{}
3308 \def\ltxdomplibcode{%
3309   \begingroup
3310   \mplibsetupcatcodes
3311   \ltxdomplibcodeindeed
3312 }
3313 \def\mplib@mplibcode{mplibcode}
3314 \long\def\ltxdomplibcodeindeed#1\end#2{%
3315   \endgroup
3316   \mplibtmptoks\expandafter{\the\mplibtmptoks#1}%
3317   \def\mplibtemp@a{#2}%
3318   \ifx\mplib@mplibcode\mplibtemp@a
3319     \directlua{luamplib.process_mplibcode([==[\the\mplibtmptoks]==],"\currentmpinstancename")}%
3320     \end{mplibcode}%

```



```

3321 \else
3322 \mplibtmptoks\expandafter{\the\mplibtmptoks\end{#2}}%
3323 \expandafter\ltxdomplibcode
3324 \fi
3325 }
3326 \fi

User settings.
3327 \def\mplibshowlog#1{\directlua{
3328   local s = string.lower("#1")
3329   if s == "enable" or s == "true" or s == "yes" then
3330     luampLib.showlog = true
3331   else
3332     luampLib.showlog = false
3333   end
3334 }}
3335 \def\mpliblegacybehavior#1{\directlua{
3336   local s = string.lower("#1")
3337   if s == "enable" or s == "true" or s == "yes" then
3338     luampLib.legacyverbatim = true
3339   else
3340     luampLib.legacyverbatim = false
3341   end
3342 }}
3343 \def\mplibverbatim#1{\directlua{
3344   local s = string.lower("#1")
3345   if s == "enable" or s == "true" or s == "yes" then
3346     luampLib.verbatiminput = true
3347   else
3348     luampLib.verbatiminput = false
3349   end
3350 }}
3351 \newtoks\mplibtmptoks

\everymplib & \everyendmplib: macros resetting luampLib.every(end)mpLib tables
3352 \ifcsname ver@luampLib.sty\endcsname
3353 \protected\def\everymplib{%
3354   \begingroup
3355   \mplibsetupcatcodes
3356   \mplibdoeverymplib
3357 }
3358 \protected\def\everyendmplib{%
3359   \begingroup
3360   \mplibsetupcatcodes
3361   \mplibdoeveryendmplib
3362 }
3363 \newcommand\mplibdoeverymplib[2][\]{%
3364   \endgroup
3365   \directlua{
3366     luampLib.everymplib["#1"] = [===[\unexpanded{#2}]===[

```

```

3367 }%
3368 }
3369 \newcommand\mplibdoeveryendmplib[2][{}]{%
3370   \endgroup
3371   \directlua{
3372     luamplib.everyendmplib["#1"] = [===[\unexpanded{#2}]===]
3373   }%
3374 }
3375 \else
3376 \def\mplibgetinstancename[#1]{\def\currentmpinstancename{#1}}
3377 \protected\def\everymplib#1#{%
3378   \ifx\empty#1\empty \mplibgetinstancename[]\else \mplibgetinstancename#1\fi
3379   \begingroup
3380   \mplibsetupcatcodes
3381   \mplibdoeverymplib
3382 }
3383 \long\def\mplibdoeverymplib#1{%
3384   \endgroup
3385   \directlua{
3386     luamplib.everymplib["\currentmpinstancename"] = [===[\unexpanded{#1}]===]
3387   }%
3388 }
3389 \protected\def\everyendmplib#1#{%
3390   \ifx\empty#1\empty \mplibgetinstancename[]\else \mplibgetinstancename#1\fi
3391   \begingroup
3392   \mplibsetupcatcodes
3393   \mplibdoeveryendmplib
3394 }
3395 \long\def\mplibdoeveryendmplib#1{%
3396   \endgroup
3397   \directlua{
3398     luamplib.everyendmplib["\currentmpinstancename"] = [===[\unexpanded{#1}]===]
3399   }%
3400 }
3401 \fi

```

TeX macros for dimen/color

```

3402 \def\mpdim#1{ \runscript("luamplibdimen{#1}") }
3403 \def\mpcolor#1#{\domplibcolor{#1}}
3404 \def\domplibcolor#1#2{ \runscript("luamplibcolor{#1{#2}}") }

```

mplib's number system. Now binary has gone away.

```

3405 \def\mplibnumbersystem#1{\directlua{
3406   local t = "#1"
3407   if t == "binary" then t = "decimal" end
3408   luamplib.numbersystem = t
3409 }}

```

Settings for .mp cache files.

```

3410 \def\mplibmakenocache#1{\mplibdomakenocache #1,*,}

```

```

3411 \def\mplibdomakenocache#1,{%
3412   \ifx\empty#1\empty
3413     \expandafter\mplibdomakenocache
3414   \else
3415     \ifx*#1\else
3416       \directlua{luamplib.noneedtoreplace["#1.mp"]=true}%
3417     \expandafter\expandafter\expandafter\mplibdomakenocache
3418     \fi
3419   \fi
3420 }
3421 \def\mplibcancelnocache#1{\mplibdocancelnocache #1*,}%
3422 \def\mplibdocancelnocache#1,{%
3423   \ifx\empty#1\empty
3424     \expandafter\mplibdocancelnocache
3425   \else
3426     \ifx*#1\else
3427       \directlua{luamplib.noneedtoreplace["#1.mp"]=false}%
3428     \expandafter\expandafter\expandafter\mplibdocancelnocache
3429     \fi
3430   \fi
3431 }
3432 \def\mplibcachedir#1{\directlua{luamplib.getcachedir("\unexpanded{#1}")}}

```

More user settings.

```

3433 \def\mplibtexttextlabel#1{\directlua{
3434   local s = string.lower("#1")
3435   if s == "enable" or s == "true" or s == "yes" then
3436     luamplib.texttextlabel = true
3437   else
3438     luamplib.texttextlabel = false
3439   end
3440 }}
3441 \def\mplibcodeinherit#1{\directlua{
3442   local s = string.lower("#1")
3443   if s == "enable" or s == "true" or s == "yes" then
3444     luamplib.codeinherit = true
3445   else
3446     luamplib.codeinherit = false
3447   end
3448 }}
3449 \def\mplibglobaltexttext#1{\directlua{
3450   local s = string.lower("#1")
3451   if s == "enable" or s == "true" or s == "yes" then
3452     luamplib.globaltexttext = true
3453   else
3454     luamplib.globaltexttext = false
3455   end
3456 }}

```

The followings are from ConT_EXt general, mostly.

We use a dedicated scratchbox.

```
3457 \ifx\mplibscratchbox\undefined \newbox\mplibscratchbox \fi
```

We encapsulate the literals.

```
3458 \def\mplibstarttoPDF#1#2#3#4{%
3459   \prependtomplibbox
3460   \hbox dir TLT\bgroup
3461   \xdef\MPllx{#1}\xdef\MPlly{#2}%
3462   \xdef\MPurx{#3}\xdef\MPury{#4}%
3463   \xdef\MPwidth{\the\dimexpr#3bp-#1bp\relax}%
3464   \xdef\MPheight{\the\dimexpr#4bp-#2bp\relax}%
3465   \parskip0pt%
3466   \leftskip0pt%
3467   \parindent0pt%
3468   \everypar{}%
3469   \setbox\mplibscratchbox\ vbox\bgroup
3470   \noindent
3471 }
3472 \def\mplibstoptoPDF{%
3473   \par
3474   \egroup %
3475   \setbox\mplibscratchbox\ hbox %
3476     {\hskip-\MPllx bp%
3477      \raise-\MPlly bp%
3478      \box\mplibscratchbox}%
3479   \setbox\mplibscratchbox\ vbox to \MPheight
3480     {\vfill
3481      \hsize\MPwidth
3482      \wd\mplibscratchbox0pt%
3483      \ht\mplibscratchbox0pt%
3484      \dp\mplibscratchbox0pt%
3485      \box\mplibscratchbox}%
3486   \wd\mplibscratchbox\MPwidth
3487   \ht\mplibscratchbox\MPheight
3488   \box\mplibscratchbox
3489   \egroup
3490 }
```

Text items have a special handler.

```
3491 \def\mplibtexttext#1#2#3#4#5{%
3492   \begingroup
3493   \setbox\mplibscratchbox\ hbox
3494     {\font\temp=#1 at #2bp%
3495      \temp
3496      #3}%
3497   \setbox\mplibscratchbox\ hbox
3498     {\hskip#4 bp%
3499      \raise#5 bp%
3500      \box\mplibscratchbox}%
3501   \wd\mplibscratchbox0pt%
```

```

3502 \ht\mplibscratchbox0pt%
3503 \dp\mplibscratchbox0pt%
3504 \box\mplibscratchbox
3505 \endgroup
3506 }

```

Input luamplib.cfg when it exists.

```

3507 \openin0=luamplib.cfg
3508 \ifeof0 \else
3509 \closein0
3510 \input luamplib.cfg
3511 \fi

```

Code for tagpdf

```

3512 \def\luamplibtagtextboxset#1#2{#2}
3513 \let\luamplibnotagtextboxset\luamplibtagtextboxset
3514 \let\luamplibtagasgroupset\relax
3515 \let\luamplibtagasgroupput\luamplibtagtextboxset
3516 \ifcsname SuspendTagging\endcsname\else\endinput\fi
3517 \ifcsname ver@tagpdf.sty\endcsname \else
3518 \ExplSyntaxOn
3519 \keys_define:nn{luamplib/tagging}
3520 {
3521 ,alt .code:n = { }
3522 ,actualtext .code:n = { }
3523 ,artifact .code:n = { }
3524 ,text .code:n = { }
3525 ,off .code:n = { }
3526 ,tag .code:n = { }
3527 ,adjust-BBox .code:n = { }
3528 ,tagging-setup .code:n = { }
3529 ,instance .code:n = { \tl_gset:Nn \currentmpinstancename {#1} }
3530 ,instancename .meta:n = { instance = {#1} }
3531 ,unknown .code:n = { \tl_gset:NV \currentmpinstancename \l_keys_key_str }
3532 }
3533 \RenewDocumentCommand\mplibcode{0{}}
3534 {
3535 \tl_gclear:N \currentmpinstancename
3536 \keys_set:ne{luamplib/tagging}{#1}
3537 \mplibtmptoks{}\ltxdomplibcode
3538 }
3539 \cs_set_eq:NN \mplibaltext \use_none:n
3540 \cs_set_eq:NN \mplibactualtext \use_none:n

```

2025/12/05: \begin{center}\mpfig ... \endmpfig\end{center} raises an Error! as we issue \everypar{} before flushing literals out. It is related to \partokencontext=2 recently introduced by L^AT_EX. Why we used vbox initially? where hbox seems to be sufficient. Anyway, among various solutions including \partokencontext\z@, \let\par\@@par, and \endgraf, we here attempt to address the issue by adding the following line, which L^AT_EX's \everypar should have done.

```

3541 \tl_put_left:Nn \mplibstoptoPDF \@newlistfalse

```

```

3542 \ExplSyntaxOff
3543 \endinput\fi
3544 \ExplSyntaxOn
3545 \tl_new:N \l__luamplib_tag_envname_tl
3546 \tl_new:N \l__luamplib_tag_alt_tl
3547 \tl_new:N \l__luamplib_tag_alt_dflt_tl
3548 \tl_new:N \l__luamplib_tag_actual_tl
3549 \tl_new:N \l__luamplib_tag_struct_tl
3550 \tl_set:Nn\l__luamplib_tag_struct_tl {Figure}
3551 \bool_new:N \l__luamplib_tag_usetext_bool
3552 \bool_new:N \l__luamplib_tag_bboxcorr_bool
3553 \seq_new:N \l__luamplib_tag_bboxcorr_seq
3554 \tl_new:N \l__luamplib_tag_bbox_draw_tl
3555 \tl_new:N \l__luamplib_BBoxllx_tl
3556 \tl_new:N \l__luamplib_BBoxlly_tl
3557 \tl_new:N \l__luamplib_BBoxurx_tl
3558 \tl_new:N \l__luamplib_BBoxury_tl
3559 \msg_new:nnn {luamplib}{figure-text-reuse}
3560 {
3561   tex-text~box~#1~probably~is~incorrectly~tagged.~
3562   Reusing~a~box~in~text~mode~is~strongly~discouraged.~
3563   Check~the~resulting~PDF.
3564 }
3565 \msg_new:nnn {luamplib}{mplibgroup-text-mode}
3566 {
3567   mplibgroup~'#1'~probably~is~incorrectly~tagged.~
3568   Using~mplibgroup~with~text~mode~is~not~recommended.~
3569   Check~the~resulting~PDF.
3570 }
3571 \msg_new:nnn {luamplib}{alt-text-missing}
3572 {
3573   Alternate~text~for~#1~is~missing.~
3574   Using~the~default~value~'#2'~instead.
3575 }

```

Sockets for tex-text boxes.

```

3576 \socket_new:nn{tagsupport/luamplib/texttext/set}{2}
3577 \socket_new:nn{tagsupport/luamplib/texttext/put}{2}
3578 \socket_new_plug:nnn{tagsupport/luamplib/texttext/set}{default}
3579 {

```

TODO: we check text mode here. If we tag text boxes for all modes, we will get a lot of structure-has-no-parent warning; no good-looking, though it seems to be no harm.

```

3580 \bool_if:NTF \l__luamplib_tag_usetext_bool
3581 {
3582   \tag_mc_end_push:
3583   \tag_struct_begin:n{tag=NonStruct, stash, parent-tag=text}
3584   \cs_gset_nopar:cpe {luamplib.taggedbox.#1} {\tag_get:n{struct_num}}

```

TODO: We force an MC. Otherwise a and b in btex a x b etex are not tagged.

```

3585 \tag_mc_begin:n{tag=text}
3586 #2
3587 \tag_mc_end:
3588 \tag_struct_end:
3589 \tag_mc_begin_pop:n{ }
3590 }
3591 {
3592 \tag_suspend:n{\luamplibtagtextboxset}
3593 #2
3594 \tag_resume:n{\luamplibtagtextboxset}
3595 }
3596 }
3597 \socket_new_plug:nnn{tagsupport/luamplib/texttext/put}{default}
3598 {
3599 \bool_lazy_and:nnTF
3600 { \l__luamplib_tag_usetext_bool }
3601 { \cs_if_free_p:c {luamplib.nottaggedbox.#1} }
3602 {
3603 \tag_resume:n{\mplibputtextbox}
3604 \tag_mc_end:
3605 \cs_if_exist:cTF {luamplib.taggedbox.#1}
3606 {
3607 \exp_args:Nc \tag_struct_use_num:n {luamplib.taggedbox.#1}
3608 #2
3609 \cs_undefine:c {luamplib.taggedbox.#1}
3610 }
3611 {
3612 \msg_warning:nnn{luamplib}{figure-text-reuse}{#1}
3613 \tag_mc_begin:n{ }
3614 \int_set:Nn \l_tmpa_int {#1}
3615 \tag_mc_reset_box:N \l_tmpa_int
3616 #2
3617 \tag_mc_end:
3618 }
3619 \tag_mc_begin:n{artifact}
3620 }
3621 {
3622 \int_set:Nn \l_tmpa_int {#1}
3623 \tag_mc_reset_box:N \l_tmpa_int
3624 #2
3625 }
3626 }
3627 \socket_assign_plug:nn{tagsupport/luamplib/texttext/set}{default}
3628 \socket_assign_plug:nn{tagsupport/luamplib/texttext/put}{default}
3629 \cs_set_nopar:Npn \luamplibtagtextboxset
3630 {
3631 \tag_socket_use:nnn{luamplib/texttext/set}
3632 }

```

For tex-text boxes starting with [taggingoff], which we will not tag at all. They will be just in

the artifact MC-chunks.

```
3633 \cs_set_nopar:Npn \luamplibnotagtextboxset #1 #2
3634 {
3635   \bool_set_eq:NN \l_tmpa_bool \l__luamplib_tag_usetext_bool
3636   \bool_set_false:N \l__luamplib_tag_usetext_bool
3637   \tag_socket_use:nnn{luamplib/texttext/set}{#1}{#2}
3638   \cs_gset_nopar:cpn {luamplib.notaggedbox.#1}{#1}
3639   \bool_set_eq:NN \l__luamplib_tag_usetext_bool \l_tmpa_bool
3640 }
3641 \cs_set_nopar:Npn \mplibputtextbox #1
3642 {
3643   \vbox to 0pt{\vss\hbox to 0pt{
3644     \socket_use:nnn{tagsupport/luamplib/texttext/put}{#1}{\raise\dp#1\copy#1}
3645     \hss}}
3646 }
```

TODO: Not sure whether asgroup/mplibgroup with text mode will be tagged correctly. Probably not. At least, this will raise a warning.

```
3647 \cs_set_nopar:Npn \luamplibtagasgroupset
3648 {
3649   \bool_set_false:N \l__luamplib_tag_usetext_bool
3650 }
3651 \cs_set_nopar:Npn \luamplibtagasgroupput
3652 {
3653   \bool_if:NT \l__luamplib_tag_usetext_bool { \tag_resume:n{\luamplibtagasgroupput} }
3654   \tag_socket_use:nnn{luamplib/mplibgroup/put}
3655 }
```

A socket for mplibgroup. Again, we issue a warning upon text mode.

```
3656 \socket_new:nn{tagsupport/luamplib/mplibgroup/put}{2}
3657 \socket_new_plug:nnn{tagsupport/luamplib/mplibgroup/put}{default}
3658 {
3659   \cs_if_free:cT {luamplib.mplibgroup.text.#1}
3660   {
3661     \msg_warning:nnn {luamplib} {mplibgroup-text-mode} {#1}
3662     \cs_gset_nopar:cpn {luamplib.mplibgroup.text.#1} {#1}
3663   }
3664   \tag_mc_end:
3665   \tag_mc_begin:n{tag=text}
3666   #2
3667   \tag_mc_end:
3668   \tag_mc_begin:n{artifact}
3669 }
3670 \socket_assign_plug:nn{tagsupport/luamplib/mplibgroup/put}{default}
```

A macro for BBox attribute

```
3671 \cs_set_nopar:Npn \__luamplib_tag_bbox_attribute:n #1
3672 {
3673   \tl_set:Ne \l_tmpa_tl {luamplib.BBox.\tag_get:n{struct_num}}
3674   \tex_savepos:D
```



```

3675 \property_record:ee{\l_tmpa_tl}{xpos,ypos}
3676 \tl_set:Ne \l__luamplib_BBox_llx_tl
3677 { \dim_to_decimal_in_bp:n { \property_ref:een {\l_tmpa_tl}{xpos}{0}sp } }
3678 \tl_set:Ne \l__luamplib_BBox_lly_tl
3679 { \dim_to_decimal_in_bp:n { \property_ref:een {\l_tmpa_tl}{ypos}{0}sp - \dp#1 } }
3680 \tl_set:Ne \l__luamplib_BBox_urx_tl
3681 { \dim_to_decimal_in_bp:n { \l__luamplib_BBox_llx_tl bp + \wd#1 } }
3682 \tl_set:Ne \l__luamplib_BBox_ury_tl
3683 { \dim_to_decimal_in_bp:n { \l__luamplib_BBox_lly_tl bp + \ht#1 + \dp#1 } }
3684 \bool_if:NT \l__luamplib_tag_bboxcorr_bool
3685 {
3686   \int_zero:N \l_tmpa_int
3687   \tl_map_inline:nn
3688   {
3689     \l__luamplib_BBox_llx_tl
3690     \l__luamplib_BBox_lly_tl
3691     \l__luamplib_BBox_urx_tl
3692     \l__luamplib_BBox_ury_tl
3693   }
3694   {
3695     \int_incr:N \l_tmpa_int
3696     \tl_set:Ne ##1
3697     {
3698       \fp_eval:n
3699       {
3700         ##1
3701         +
3702         \dim_to_decimal_in_bp:n { \seq_item:NV \l__luamplib_tag_bboxcorr_seq \l_tmpa_int }
3703       }
3704     }
3705   }
3706 }
3707 \tag_struct_gput:ene {\tag_get:n{struct_num}} {attribute}
3708 {
3709   /O /Layout /BBox [
3710     \l__luamplib_BBox_llx_tl\c_space_tl
3711     \l__luamplib_BBox_lly_tl\c_space_tl
3712     \l__luamplib_BBox_urx_tl\c_space_tl
3713     \l__luamplib_BBox_ury_tl
3714   ]
3715 }
3716 \bool_if:NT \l__tag_graphic_debug_bool
3717 {
3718   \iow_log:e
3719   {
3720     luamplib/tagging~debug:~BBox~of~structure~\tag_get:n{struct_num}~is~
3721     \l__luamplib_BBox_llx_tl\c_space_tl
3722     \l__luamplib_BBox_lly_tl\c_space_tl
3723     \l__luamplib_BBox_urx_tl\c_space_tl

```

```

3724     \l__luamplib_BBox_ury_tl
3725   }
3726   \sys_if_output_pdf:TF
3727   {
3728     \tl_set:Nx \l__luamplib_tag_bbox_draw_tl
3729     {
3730       \pdfextension save\relax
3731       \opacity_select:n{0.5} \color_select:n{red}
3732       \pdfextension literal~text
3733       {
3734         \l__luamplib_BBox_llx_tl\c_space_tl
3735         \l__luamplib_BBox_lly_tl\c_space_tl
3736         \fp_eval:n { \l__luamplib_BBox_urx_tl - \l__luamplib_BBox_llx_tl }~
3737         \fp_eval:n { \l__luamplib_BBox_ury_tl - \l__luamplib_BBox_lly_tl }~
3738         re~f
3739       }
3740       \pdfextension restore\relax
3741     }
3742   }
3743   {
3744     \tl_set:Nx \l__luamplib_tag_bbox_draw_tl
3745     {
3746       \special{pdf:bcontent}
3747       \opacity_select:n{0.5} \color_select:n{red}
3748       \special{pdf:code~
3749         1~0~0~1~
3750         -\dim_to_decimal_in_bp:n { \property_ref:een{\l_tmpa_tl}{xpos}{0}sp + \wd#1 }~
3751         -\dim_to_decimal_in_bp:n { \property_ref:een{\l_tmpa_tl}{ypos}{0}sp }~
3752         cm
3753       }
3754       \special{pdf:code~
3755         \l__luamplib_BBox_llx_tl\c_space_tl
3756         \l__luamplib_BBox_lly_tl\c_space_tl
3757         \fp_eval:n { \l__luamplib_BBox_urx_tl - \l__luamplib_BBox_llx_tl }~
3758         \fp_eval:n { \l__luamplib_BBox_ury_tl - \l__luamplib_BBox_lly_tl }~
3759         re~f
3760       }
3761       \special{pdf:econtent}
3762     }
3763   }
3764 }
3765 }

```

Sockets for main process

```

3766 \socket_new:nn{tagsupport/luamplib/figure/begin}{1}
3767 \socket_new:nn{tagsupport/luamplib/figure/end}{2}
3768 \socket_new_plug:nnn{tagsupport/luamplib/figure/end}{transparent}{#2}
3769 \socket_new_plug:nnn{tagsupport/luamplib/figure/begin}{alt}
3770 {

```

```

3771 \tag_mc_end_push:
3772 \tl_if_empty:NT\l__luamplib_tag_alt_tl
3773 {
3774   \tl_if_empty:eTF{#1}
3775   { \tl_set:Nn \l__luamplib_tag_alt_tl {metapost~figure} }
3776   { \tl_set:Nc \l__luamplib_tag_alt_tl {metapost~figure~\text_purify:n{#1}} }
3777   \msg_warning:nnVV{luamplib}{alt-text-missing}
3778   \l__luamplib_tag_envname_tl \l__luamplib_tag_alt_tl
3779 }
3780 \tag_struct_begin:n
3781 {
3782   tag=\l__luamplib_tag_struct_tl,
3783   alt=\l__luamplib_tag_alt_tl,
3784 }
3785 \tag_mc_begin:n{ }
3786 }
3787 \socket_new_plug:nnn{tagsupport/luamplib/figure/end}{alt}
3788 {
3789   \__luamplib_tag_bbox_attribute:n {#1}
3790   #2
3791   \tl_use:N \l__luamplib_tag_bbox_draw_tl
3792   \tag_mc_end:
3793   \tag_struct_end:
3794   \tag_mc_begin_pop:n{ }
3795 }
3796 \socket_new_plug:nnn{tagsupport/luamplib/figure/begin}{actualtext}
3797 {
3798   \tag_mc_end_push:
3799   \tag_struct_begin:n
3800   {
3801     tag=Span,
3802     actualtext=\l__luamplib_tag_actual_tl,
3803   }
3804   \tag_mc_begin:n{ }
3805 }
3806 \socket_new_plug:nnn{tagsupport/luamplib/figure/end}{actualtext}
3807 {
3808   #2
3809   \tag_mc_end:
3810   \tag_struct_end:
3811   \tag_mc_begin_pop:n{ }
3812 }
3813 \socket_new_plug:nnn{tagsupport/luamplib/figure/begin}{artifact}
3814 {
3815   \tag_mc_end_push:
3816   \tag_mc_begin:n{artifact}
3817 }
3818 \socket_new_plug:nnn{tagsupport/luamplib/figure/end}{artifact}
3819 {

```

```

3820    #2
3821    \tag_mc_end:
3822    \tag_mc_begin_pop:n{ }
3823 }

```

A socket for tagging init, so that we can declare `\SetKeys[luamplib/tagging]{...}` anywhere in the document.

```

3824 \socket_new:nn{tagsupport/luamplib/figure/init}{0}
3825 \socket_new_plug:nnn{tagsupport/luamplib/figure/init}{alt}
3826 {
3827   \socket_assign_plug:nn{tagsupport/luamplib/figure/begin}{alt}
3828   \socket_assign_plug:nn{tagsupport/luamplib/figure/end}{alt}
3829 }
3830 \socket_new_plug:nnn{tagsupport/luamplib/figure/init}{actualtext}
3831 {
3832   \socket_assign_plug:nn{tagsupport/luamplib/figure/begin}{actualtext}
3833   \socket_assign_plug:nn{tagsupport/luamplib/figure/end}{actualtext}

```

In vmode, hmode will be forced by `\noindent` upon actualtext and text modes.

```

3834 \prependtomplibbox \mplibnoforcehmode
3835 \mode_if_vertical:T { \noindent \aftergroup\par }
3836 }
3837 \socket_new_plug:nnn{tagsupport/luamplib/figure/init}{artifact}
3838 {
3839   \socket_assign_plug:nn{tagsupport/luamplib/figure/begin}{artifact}
3840   \socket_assign_plug:nn{tagsupport/luamplib/figure/end}{artifact}
3841 }
3842 \socket_new_plug:nnn{tagsupport/luamplib/figure/init}{text}
3843 {
3844   \bool_set_true:N \l__luamplib_tag_usetext_bool
3845   \socket_assign_plug:nn{tagsupport/luamplib/figure/begin}{artifact}
3846   \socket_assign_plug:nn{tagsupport/luamplib/figure/end}{artifact}
3847   \prependtomplibbox \mplibnoforcehmode
3848   \mode_if_vertical:T { \noindent \aftergroup\par }
3849 }
3850 \socket_new_plug:nnn{tagsupport/luamplib/figure/init}{off}
3851 {
3852   \socket_assign_plug:nn{tagsupport/luamplib/figure/begin}{noop}
3853   \socket_assign_plug:nn{tagsupport/luamplib/figure/end}{transparent}
3854 }
3855 \socket_assign_plug:nn{tagsupport/luamplib/figure/init}{alt}

```

Key-value options

```

3856 \keys_define:nn{luamplib/tagging}
3857 {
3858   ,alt .code:n =
3859   {
3860     \tl_set:N\l__luamplib_tag_alt_tl{\text_purify:n{#1}}
3861     \socket_assign_plug:nn{tagsupport/luamplib/figure/init}{alt}
3862   }

```

```

3863 ,actualtext .code:n =
3864 {
3865   \tl_set:N\l__luamplib_tag_actual_tl{\text_purify:n{#1}}
3866   \socket_assign_plug:nn{tagsupport/luamplib/figure/init}{actualtext}
3867 }
3868 ,artifact .code:n = { \socket_assign_plug:nn{tagsupport/luamplib/figure/init}{artifact} }
3869 ,text .code:n = { \socket_assign_plug:nn{tagsupport/luamplib/figure/init}{text} }
3870 ,off .code:n = { \socket_assign_plug:nn{tagsupport/luamplib/figure/init}{off} }
3871 ,tag .code:n =
3872 {
3873   \str_case:nnF {#1}
3874   {
3875     {false} { \keys_set:nn {luamplib/tagging} {off} }
3876     {artifact} { \keys_set:nn {luamplib/tagging} {artifact} }
3877   }
3878   {
3879     \tl_set:Nn\l__luamplib_tag_struct_tl{#1}
3880     \socket_assign_plug:nn{tagsupport/luamplib/figure/init}{alt}
3881   }
3882 }
3883 ,adjust-BBox .code:n =
3884 {
3885   \bool_set_true:N \l__luamplib_tag_bboxcorr_bool
3886   \seq_set_split:Nnn \l__luamplib_tag_bboxcorr_seq{~}{#1~0pt~0pt~0pt~0pt}
3887 }
3888 ,tagging-setup .code:n = { \keys_set_known:nn {luamplib/tagging} {#1} }
3889 }
3890 \keys_define:nn {luamplib/instance}
3891 {
3892   ,instance .code:n = { \tl_gset:Nn \currentmpinstancename {#1} }
3893   ,instancename .meta:n = { instance = {#1} }
3894   ,unknown .code:n = { \tl_gset:NV \currentmpinstancename \l_keys_key_str }
3895 }

```

Redefine our macros

```

3896 \cs_set_nopar:Npn \mplibstarttoPDF #1 #2 #3 #4
3897 {
3898   \prependtomplibbox
3899   \hbox_dir~TLT\bgroup
3900     \tag_socket_use:nn{luamplib/figure/begin}\l__luamplib_tag_alt_dflt_tl
3901     \xdef\MPlIx{#1}\xdef\MPlly{#2}%
3902     \xdef\MPlrx{#3}\xdef\MPlry{#4}%
3903     \xdef\MPlwidth{\the\dimexpr#3bp-#1bp\relax}%
3904     \xdef\MPlheight{\the\dimexpr#4bp-#2bp\relax}%
3905     \parskip0pt
3906     \leftskip0pt
3907     \parindent0pt
3908     \everypar{}%
3909     \setbox\mplibscratchbox\vbox\bgroup

```

```

3910     \tag_suspend:n{\mplibstarttoPDF}
3911     \noindent
3912 }
3913 \cs_set_nopar:Npn \mplibstoptoPDF
3914 {
3915     \par
3916     \egroup
3917     \setbox\mplibscratchbox\hbox
3918     {\hskip-\MPllx bp
3919      \raise-\MPlly bp
3920      \box\mplibscratchbox}%
3921     \setbox\mplibscratchbox\vbox to \MPheight
3922     {\vfill
3923      \hsize\MPwidth
3924      \wd\mplibscratchbox0pt
3925      \ht\mplibscratchbox0pt
3926      \dp\mplibscratchbox0pt
3927      \box\mplibscratchbox}%
3928     \wd\mplibscratchbox\MPwidth
3929     \ht\mplibscratchbox\MPheight
3930     \tag_socket_use:nnn{luamplib/figure/end}{\mplibscratchbox}{\box\mplibscratchbox}
3931     \egroup
3932 }
3933 \RenewDocumentCommand\mplibcode{0{}}
3934 {
3935     \tl_set:Nn \l__luamplib_tag_envname_tl {mplibcode}
3936     \tl_gclear:N \currentmpinstancename
3937     \keys_set_known:neN {luamplib/tagging} {#1} \l_tmpa_tl
3938     \keys_set:nV {luamplib/instance} \l_tmpa_tl
3939     \tl_set_eq:NN \l__luamplib_tag_alt_dflt_tl \currentmpinstancename
3940     \tag_socket_use:n{luamplib/figure/init}
3941     \mplibtmptoks{}\ltxdomplibcode
3942 }
3943 \RenewDocumentCommand\mpfig{s 0{}}
3944 {
3945     \begingroup
3946     \tl_set:Nn \l__luamplib_tag_envname_tl {mpfig}
3947     \keys_set_known:ne {luamplib/tagging} {#2}
3948     \tl_set_eq:NN \l__luamplib_tag_alt_dflt_tl \mpfiginstancename
3949     \tag_socket_use:n{luamplib/figure/init}
3950     \IfBooleanTF{#1} { \mplibprempfig * }
3951                     { \mplibmainmpfig }
3952 }
3953 \RenewDocumentCommand\usemplibgroup{0{ } m}
3954 {
3955     \begingroup
3956     \tl_set:Nn \l__luamplib_tag_envname_tl {usemplibgroup}
3957     \keys_set_known:ne {luamplib/tagging} {#1}
3958     \tag_socket_use:n{luamplib/figure/init}

```

```

3959 \prependtomplibbox\hbox dir~TLT\bgroup
3960   \tag_socket_use:nn{luamplib/figure/begin}{#2}
3961   \setbox\mplibscratchbox\hbox\bgroup
3962     \bool_if:NF \l__luamplib_tag_usetext_bool { \tag_suspend:n{\usemplibgroup} }
3963     \tag_socket_use:nnn{luamplib/mpplibgroup/put}{#2}{\csname luamplib.group.#2\endcsname}
3964     \egroup
3965     \tag_socket_use:nnn{luamplib/figure/end}{\mplibscratchbox}{\unhbox\mplibscratchbox}
3966   \egroup
3967 \endgroup
3968 }

```

Allow setting alt/actual text within METAPOST code. Of course we can use them in T_EX code as well.

```

3969 \cs_new_nopar:Npn \mplibalttext #1
3970 {
3971   \tl_set:Nc \l__luamplib_tag_alt_tl {\text_purify:n{#1}}
3972 }
3973 \cs_new_nopar:Npn \mplibactualtext #1
3974 {
3975   \tl_set:Nc \l__luamplib_tag_actual_tl {\text_purify:n{#1}}
3976 }
3977 \ExplSyntaxOff

```

That's all folks!

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Version 2, June 1991

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