The luamplib package

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Abstract

Package to have metapost code typeset directly in a document with LuaTEX.

1 Documentation

This packages aims at providing a simple way to typeset directly metapost code in a document with LuaTEX. LuaTEX is built with the lua `mplib` library, that runs metapost code. This package is basically a wrapper (in Lua) for the Lua `mplib` functions and some TEX functions to have the output of the `mplib` functions in the pdf.

In the past, the package required PDF mode in order to output something. Starting with version 2.7 it works in DVI mode as well, though DVIPDFMx is the only DVI tool currently supported.

The metapost figures are put in a TEX `hbox` with dimensions adjusted to the metapost code.

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 code is from the `luatex-mplib.lua` and `luatex-mplib.tex` files from ConTEXt, they have been adapted to LATEX and Plain by Elie Roux and Philipp Gesang, new functionalities have been added by Kim Dohyun. The changes are:

- a LATEX environment
- all TEX macros start by `mplib`
- use of our own function for errors, warnings and informations
- possibility to use `btex ... etex` to typeset TEX code. `textext()` is a more versatile macro equivalent to `TEX()` from TEX.mp. `TEX()` is also allowed and is a synomym of `textext()`.

  N.B. Since v2.5, `btex ... etex` input from external `mp` files will also be processed by luamplib.

  N.B. Since v2.20, `verbatimtex ... etex` from external `mp` files will be also processed by luamplib. Warning: This is a change from previous version.

Some more changes and cautions are:

\mplibforcehmode When this macro is declared, every mplibcode figure box will be typeset in horizontal mode, so \centering, \raggedleft etc will have effects. \mplibnoforcehmode, being default, reverts this setting. (Actually these commands redefine \prependtomplibbox. You can define this command with anything suitable before a box.)

\mpfig ... \endmpfig Since v2.29 we provide unexpandable TEX macros \mpfig ... \endmpfig and its starred version \mpfig* ... \endmpfig to save typing toil. The first 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} (see below) is forcibly declared. And as both share the same instance name, metapost codes are inherited among them. A simple example:

```
\mpfig* input boxes \endmpfig
\everymplib[@mpfig]{ drawoptions(withcolor .5[red,white]); }
\mpfig circleit.a(btex Box 1 etex); drawboxed(a); \endmpfig
```

The instance name (default: @mpfig) can be changed 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{true} (see below) is not declared.[1]

\mpliblegacybehavior{enable} By default, \mpliblegacybehavior{enable} is already declared, in which case a verbatimtex ... etex that comes just before beginfig() is not ignored, but the TEX code will be inserted before the following mplib hbox. Using this command, each mplib box can be freely moved horizontally and/or vertically. Also, a box number might be assigned to mplib box, allowing it to be reused later (see test files).

```
\mplibcode
verbatimtex \moveright 3cm etex; beginfig(0); ... endfig;
verbatimtex \leavevmode etex; beginfig(1); ... endfig;
verbatimtex \leavevmode\lower 1ex etex; beginfig(2); ... endfig;
verbatimtex \endgraf\moveright 1cm etex; beginfig(3); ... endfig;
\endmplibcode
```

[1] As for user setting values, enable, true, yes are identical, and disable, false, no are identical.

N.B. \endgraf should be used instead of \par inside verbatimtex ... etex.

By contrast, TEX code in VerbatimTeX(...) or verbatimtex ... etex between beginfig() and endfig will be inserted after flushing out the mplib figure.

```
\mplibcode
  D := sqrt(2)**7;
  beginfig(0);
  draw fullcircle scaled D;
  VerbatimTeX("\gdef\Dia{" & decimal D & "}");
  endfig;
\endmplibcode
diameter: \Dia bp.
```

\mpliblegacybehavior{disable} If \mpliblegacybehavior{disabled} is declared by user, any verbatimtex ... etex will be executed, along with btex ... etex, sequentially one by one. So, some TEX code in verbatimtex ... etex will have effects on btex ... etex codes that follows.

```
\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}
```

\everymplib, \everyendmplib Since v2.3, new macros \everymplib and \everyendmplib redefine the lua table containing MetaPost code which will be automatically inserted at the beginning and ending of each mplibcode.

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

\mpdim Since v2.3, \mpdim and other raw TEX commands are allowed inside mplib code. This feature is inpired by gmp.sty authored by Enrico Gregorio. Please refer the manual of gmp package for details.

```
\begin{mplibcode}
  draw origin--(.6\mpdim{\linewidth},0) withpen pencircle scaled 4
  dashed evenly scaled 4 withcolor \mpcolor{orange};
\end{mplibcode}
```

N.B. Users should not use the protected variant of btex ... etex as provided by gmp package. As luamplib automatically protects TEX code inbetween, \btex is not supported here.

\mpcolor With \mpcolor command, color names or expressions of color/xcolor packages can be used inside mplibcode enviroment (after withcolor operator), though luamplib does not automatically load these packages. See the example code above. For spot colors, colorspace, spotcolor (in PDF mode) and xespotcolor (in DVI mode) packages are supported as well.

From v2.26.1, l3color is also supported by the command \mpcolor{color expression}, including spot colors.

\mplibnumbersystem Users can choose numbersystem option since v2.4. The default value scaled can be changed to double or decimal by declaring \mplibnumbersystem{double} or \mplibnumbersystem{decimal}. For details see http://github.com/lualatex/luamplib/issues/21.

\mplibtextextlabel Starting with v2.6, \mplibtextextlabel{enable} enables string labels typeset via textext() instead of infont operator. So, label("my text",origin) thereafter is exactly the same as label(textext("my text"),origin). N.B. In the background, luamplib redefines infont operator so that the right side argument (the font part) is totally ignored. Every string label therefore will be typeset with current TEX font. Also take care of char operator in the left side argument, as this might bring unpermitted characters into TEX.

\mplibcodeinherit Starting with v2.9, \mplibcodeinherit{enable} enables the inheritance of variables, constants, and macros defined by previous mplibcode chunks. On the contrary, the default value \mplibcodeinherit{disable} will make each code chunks being treated as an independent instance, and never affected by previous code chunks.

Separate instances for LATEX and plain TEX v2.22 has added the support for several named MetaPost instances in LATEX mplibcode environment. (And since v2.29 plain TEX users can use this functionality as well.) Syntax is like so:

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

Behaviour is as follows.

- All the variables and functions are shared only among all the environments belonging to the same instance.
- \mplibcodeinherit only affects environments with no instance name set (since if a name is set, the code is intended to be reused at some point).
- From v2.27, btex ... etex boxes are also shared and do not require \mplibglobaltextext.
- When an instance names is set, respective \currentmpinstancename is set.

In parellel with this functionality, v2.23 and after supports 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. Syntax is:

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

\mplibglobaltextext Formerly, to inherit btex ... etex boxes as well as metapost variables, it was necessary to declare \mplibglobaltextext{enable} in advance. But from v2.27, this is implicitly enabled when \mplibcodeinherit is true.

```
\mplibcodeinherit{enable}
%\mplibglobaltextext{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
```

Generally speaking, it is recommended to turn mplibglobaltextext always on, because it has the advantage of reusing metapost pictures among code chunks. But everything has its downside: it will waste more memory resources.

\mplibverbatim Starting with v2.11, users can issue \mplibverbatim{enable}, after which the contents of mplibcode environment will be read verbatim. As a result, except for \mpdim and \mpcolor, all other TEX commands outside btex ... etex or verbatimtex ... etex are not expanded and will be fed literally into the mplib process.

\mplibshowlog When \mplibshowlog{enable} is declared, log messages returned by mplib instance will be printed into the .log file. \mplibshowlog{disable} will revert this functionality. This is a TEX side interface for luamplib.showlog. (v2.20.8)

Settings regarding cache files To support btex ... etex in external .mp files, luamplib inspects the content of each and every .mp input files and makes caches if nececcsary, before returning their paths to LuaTEX's mplib library. This would make the compilation time longer wastefully, as most .mp files do not contain btex ... etex command. So luamplib provides macros as follows, so that users can give instruction about files that do not require this functionality.

- \mplibmakenocache{<filename>[,<filename>,...]}
- \mplibcancelnocache{<filename>[,<filename>,...]}

where <filename> is a file name 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.) This behavior however can be changed 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.

mplibtexcolor, mplibrgbtexcolor mplibtexcolor is a metapost operator that converts a TEX color expression to a MetaPost color expression. For instance:

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

The result may vary in its color model (gray/rgb/cmyk) according to the given TEX color. (Spot colors are forced to cmyk model, so this operator is not recommended for spot colors.) Therefore the example shown above would raise a metapost error: `cmykcolor col;` should have been declared. By contrast, mplibrgbtexcolor always returns rgb model expressions.

mplibgraphictext For some amusement, luamplib provides its own metapost operator mplibgraphictext, the effect of which is similar to that of ConTEXt's graphictext. However syntax is somewhat different.

```
mplibgraphictext "Funny"
  fakebold 2.3                        % fontspec option
  drawcolor .7blue fillcolor "red!50" % color expressions
```

fakebold, drawcolor and fillcolor are optional; default values are 2, "black" and "white" respectively. When color expressions are given as string, they are regarded as xcolor's or l3color's expressions (this is the same with shading colors). From v2.30, scale option is deprecated and is now a synonym of scaled. All from mplibgraphictext to the end of sentence will compose an anonymous picture, which can be drawn or assigned to a variable. Incidentally, withdrawcolor and withfillcolor are synonyms of drawcolor and fillcolor, hopefully to be compatible with graphictext. N.B. Because luamplib's current implementation is quite different from the ConTEXt's, there are some limitations such that you can't apply shading (gradient colors) to the text (But see below). In DVI mode, unicode-math package is needed for math formula graphictext, as we cannot embolden type1 fonts in DVI mode.

mplibglyph, mplibdrawglyph 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 "of" can be either a number or a string. Number arguments are regarded as a glyph slot (GID) and a font id number, repectively. 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.

The returned picture will be quite similar to the result of glyph primitive in its structure. So, metapost's draw command will fill the inner path of the picture with background color. In contrast, mplibdrawglyph 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.

mpliboutlinetext From v2.31, we provide a new metapost operator mpliboutlinetext, which mimicks metafun's outlinetext. So the syntax is the same as metafun's. See the metafun manual § 8.7 (texdoc metafun). A simple example:

```
draw mpliboutlinetext.b ("$\sqrt{2+\alpha}$")
    (withcolor \mpcolor{red!50})
    (withpen pencircle scaled .2 withcolor red)
    scaled 2 ;
```

After the process of mpliboutlinetext, mpliboutlinepic[] and mpliboutlinenum will be preserved as global variables; mpliboutlinepic[1] ... mpliboutlinepic[mpliboutlinenum] will be an array of images each of which containing 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.

\mppattern ... \endmppattern, withpattern \mppattern{<name>} ... \endmppattern defines a tiling pattern associated with the <name>. MetaPost operator withpattern, the syntax being *path* withpattern *string*, will return a metapost picture which fills the given path with a tiling pattern of the <name>.

```
\mppattern{mypatt}          % or \begin{mppattern}{mypatt}
  [ xstep = 10, ystep = 12 ] % options: see below
  \mpfig                    % or any other TeX code,
    picture q;
    q := btex Q etex;
    fill bbox q withcolor .8[red,white];
    draw q withcolor .8red;
  \endmpfig
\endmppattern               % or \end{mppattern}

\mpfig
  fill fullcircle scaled 100 withpostscript "collect";
  draw unitsquare shifted - center unitsquare scaled 45
    withpattern "mypatt"
    withpostscript "evenodd" ;
\endmpfig
```

The available options are:

Key	Value Type	Explanation
xstep	*number*	horizontal spacing between pattern cells
ystep	*number*	vertical spacing between pattern cells
xshift	*number*	horizontal shifting of pattern cells
yshift	*number*	vertical shifting of pattern cells
bbox	*string*	llx lly urx ury values separated by spaces
matrix	*string*	xx xy yx yy values separated by spaces
resources	*string*	PDF resources if needed
colored	*boolean*	false for uncolored pattern. default: true

When you use special effects such as transparency in a pattern, resources option might be needed: for instance, resources="/ExtGState 1 0 R".

Option colored=false will generate an uncolored pattern which shall have no color at all. Uncolored pattern will be painted later by the color of a metapost object. An example:

```
\begin{mppattern}{pattuncolored}
  [
    colored = false,
    matrix = "0.7071 0.7071 -0.7071 0.7071",
  ]
  \tiny\TeX
\end{mppattern}

\begin{mplibcode}
  beginfig(1)
  picture tex; tex := mpliboutlinetext.p ("\bfseries \TeX");
  i:=0;
  for item within tex:
    i:=i+1;
    if i < length tex:
      fill pathpart item scaled 10
           withpostscript "collect";
    else:
      draw pathpart item scaled 10
           withpattern "pattuncolored"
           withcolor 0.7 blue          % paints the pattern
           ;
    fi
  endfor
  endfig;
\end{mplibcode}
```

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

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.

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*⟩`}`.

2 Implementation

2.1 Lua module

```
1
2 luatexbase.provides_module {
3   name          = "luamplib",
4   version       = "2.32.0",
5   date          = "2024/06/10",
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. ConTEXt uses `metapost`.

```
9 luamplib          = luamplib or { }
10 local luamplib    = luamplib
11
12 local format, abs = string.format, math.abs
13
```

Use our own function for warn/info/err.

```
14 local function termorlog (target, text, kind)
15   if text then
16     local mod, write, append = "luamplib", texio.write_nl, texio.write
17     kind = kind
18         or target == "term" and "Warning (more info in the log)"
19         or target == "log" and "Info"
20         or target == "term and log" and "Warning"
21         or "Error"
22     target = kind == "Error" and "term and log" or target
23     local t = text:explode"\n+"
24     write(target, format("Module %s %s:", mod, kind))
25     if #t == 1 then
26       append(target, format(" %s", t[1]))
27     else
28       for _,line in ipairs(t) do
29         write(target, line)
30       end
31       write(target, format("(%s)     ", mod))
32     end
33     append(target, format(" on input line %s", tex.inputlineno))
34     write(target, "")
35     if kind == "Error" then error() end
36   end
37 end
38
39 local function warn (...) -- beware '%' symbol
40   termorlog("term and log", select("#",...) > 1 and format(...) or ...)
41 end
```

```
local function info (...)
  termorlog("log", select("#",...) > 1 and format(...) or ...)
end
local function err (...)
  termorlog("error", select("#",...) > 1 and format(...) or ...)
end

luamplib.showlog  = luamplib.showlog or false

```

This module is a stripped down version of libraries that are used by ConTEXt. Provide a few “shortcuts” expected by the imported code.

```
local tableconcat = table.concat
local tableinsert = table.insert
local texsprint   = tex.sprint
local texgettoks  = tex.gettoks
local texgetbox   = tex.getbox
local texruntoks  = tex.runtoks
```

We don’t use `tex.scantoks` anymore. See below reagrding `tex.runtoks`.

```
  local texscantoks = tex.scantoks


if not texruntoks then
  err("Your LuaTeX version is too old. Please upgrade it to the latest")
end

local is_defined  = token.is_defined
local get_macro   = token.get_macro

local mplib = require ('mplib')
local kpse  = require ('kpse')
local lfs   = require ('lfs')

local lfsattributes = lfs.attributes
local lfsisdir      = lfs.isdir
local lfsmkdir      = lfs.mkdir
local lfstouch      = lfs.touch
local ioopen        = io.open

```

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

```
local file = file or { }
local replacesuffix = file.replacesuffix or function(filename, suffix)
  return (filename:gsub("%.[%a%d]+$","")) .. "." .. suffix
end

local is_writable = file.is_writable or function(name)
  if lfsisdir(name) then
    name = name .. "/_luam_plib_temp_file_"
    local fh = ioopen(name,"w")
    if fh then
      fh:close(); os.remove(name)
      return true
    end
```

```
  end
end
local mk_full_path = lfs.mkdirp or lfs.mkdirs or function(path)
  local full = ""
  for sub in path:gmatch("(/*[^\\/]+)") do
    full = full .. sub
    lfsmkdir(full)
  end
end

```

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.

```
local luamplibtime = kpse.find_file("luamplib.lua")
luamplibtime = luamplibtime and lfsattributes(luamplibtime,"modification")

local currenttime = os.time()

local outputdir, cachedir
if lfstouch then
  for i,v in ipairs{'TEXMFVAR','TEXMF_OUTPUT_DIRECTORY','.','TEXMFOUTPUT'} do
    local var = i == 3 and v or kpse.var_value(v)
    if var and var ~= "" then
      for _,vv in next, var:explode(os.type == "unix" and ":" or ";") do
        local dir = format("%s/%s",vv,"luamplib_cache")
        if not lfsisdir(dir) then
          mk_full_path(dir)
        end
        if is_writable(dir) then
          outputdir = dir
          break
        end
      end
      if outputdir then break end
    end
  end
end
outputdir = outputdir or '.'
function luamplib.getcachedir(dir)
  dir = dir:gsub("##","#")
  dir = dir:gsub("^~",
    os.type == "windows" and os.getenv("UserProfile") or os.getenv("HOME"))
  if lfstouch and dir then
    if lfsisdir(dir) then
      if is_writable(dir) then
        cachedir = dir
      else
        warn("Directory '%s' is not writable!", dir)
      end
    else
      warn("Directory '%s' does not exist!", dir)
    end
  end
```

```
end

```

Some basic MetaPost files not necessary to make cache files.

```
local noneedtoreplace = {
  ["boxes.mp"] = true, --  ["format.mp"] = true,
  ["graph.mp"] = true, ["marith.mp"] = true, ["mfplain.mp"] = true,
  ["mpost.mp"] = true, ["plain.mp"] = true, ["rboxes.mp"] = true,
  ["sarith.mp"] = true, ["string.mp"] = true, -- ["TEX.mp"] = true,
  ["metafun.mp"] = true, ["metafun.mpiv"] = true, ["mp-abck.mpiv"] = true,
  ["mp-apos.mpiv"] = true, ["mp-asnc.mpiv"] = true, ["mp-bare.mpiv"] = true,
  ["mp-base.mpiv"] = true, ["mp-blob.mpiv"] = true, ["mp-butt.mpiv"] = true,
  ["mp-char.mpiv"] = true, ["mp-chem.mpiv"] = true, ["mp-core.mpiv"] = true,
  ["mp-crop.mpiv"] = true, ["mp-figs.mpiv"] = true, ["mp-form.mpiv"] = true,
  ["mp-func.mpiv"] = true, ["mp-grap.mpiv"] = true, ["mp-grid.mpiv"] = true,
  ["mp-grph.mpiv"] = true, ["mp-idea.mpiv"] = true, ["mp-luas.mpiv"] = true,
  ["mp-mlib.mpiv"] = true, ["mp-node.mpiv"] = true, ["mp-page.mpiv"] = true,
  ["mp-shap.mpiv"] = true, ["mp-step.mpiv"] = true, ["mp-text.mpiv"] = true,
  ["mp-tool.mpiv"] = true, ["mp-cont.mpiv"] = true,
}
luamplib.noneedtoreplace = noneedtoreplace

```

`format.mp` is much complicated, so specially treated.

```
local function replaceformatmp(file,newfile,ofmodify)
  local fh = ioopen(file,"r")
  if not fh then return file end
  local data = fh:read("*all"); fh:close()
  fh = ioopen(newfile,"w")
  if not fh then return file end
  fh:write(
    "let normalinfont = infont;\n",
    "primarydef str infont name = rawtextext(str) enddef;\n",
    data,
    "vardef Fmant_(expr x) = rawtextext(decimal abs x) enddef;\n",
    "vardef Fexp_(expr x) = rawtextext(\"$^{\"&decimal x&\"}$\") enddef;\n",
    "let infont = normalinfont;\n"
  ); fh:close()
  lfstouch(newfile,currenttime,ofmodify)
  return newfile
end

```

Replace `btex ... etex` and `verbatimtex ... etex` in input files, if needed.

```
local name_b = "%f[%a_]"
local name_e = "%f[^%a_]"
local btex_etex = name_b.."btex"..name_e.."%s*(.-)%s*"..name_b.."etex"..name_e
local verbatimtex_etex = name_b.."verbatimtex"..name_e.."%s*(.-)%s*"..name_b.."etex"..name_e

local function replaceinputmpfile (name,file)
  local ofmodify = lfsattributes(file,"modification")
  if not ofmodify then return file end
  local newfile = name:gsub("%W","_")
  newfile = format("%s/luamplib_input_%s", cachedir or outputdir, newfile)
  if newfile and luamplibtime then
```

```
    local nf = lfsattributes(newfile)
    if nf and nf.mode == "file" and
      ofmodify == nf.modification and luamplibtime < nf.access then
      return nf.size == 0 and file or newfile
    end
  end

  if name == "format.mp" then return replaceformatmp(file,newfile,ofmodify) end

  local fh = ioopen(file,"r")
  if not fh then return file end
  local data = fh:read("*all"); fh:close()

```

"etex" must be followed by a space or semicolon as specified in LuaTEX manual, which is not the case of standalone MetaPost though.

```
  local count,cnt = 0,0
  data, cnt = data:gsub(btex_etex, "btex %1 etex ") -- space
  count = count + cnt
  data, cnt = data:gsub(verbatimtex_etex, "verbatimtex %1 etex;") -- semicolon
  count = count + cnt

  if count == 0 then
    noneedtoreplace[name] = true
    fh = ioopen(newfile,"w");
    if fh then
      fh:close()
      lfstouch(newfile,currenttime,ofmodify)
    end
    return file
  end

  fh = ioopen(newfile,"w")
  if not fh then return file end
  fh:write(data); fh:close()
  lfstouch(newfile,currenttime,ofmodify)
  return newfile
end

```

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

```
local mpkpse
do
  local exe = 0
  while arg[exe-1] do
    exe = exe-1
  end
  mpkpse = kpse.new(arg[exe], "mpost")
end

local special_ftype = {
  pfb = "type1 fonts",
  enc = "enc files",
}
```

```
236
237 function luamplib.finder (name, mode, ftype)
238   if mode == "w" then
239     if name and name ~= "mpout.log" then
240       kpse.record_output_file(name) -- recorder
241     end
242     return name
243   else
244     ftype = special_ftype[ftype] or ftype
245     local file = mpkpse:find_file(name,ftype)
246     if file then
247       if lfstouch and ftype == "mp" and not noneedtoreplace[name] then
248         file = replaceinputmpfile(name,file)
249       end
250     else
251       file = mpkpse:find_file(name, name:match("%a+$"))
252     end
253     if file then
254       kpse.record_input_file(file) -- recorder
255     end
256     return file
257   end
258 end
259
```

Create and load MPLib instances. We do not support ancient version of MPLib any more. (Don't know which version of MPLib started to support `make_text` and `run_script`; let the users find it.)

```
260 local preamble = [[
261   boolean mplib ; mplib := true ;
262   let dump = endinput ;
263   let normalfontsize = fontsize;
264   input %s ;
265 ]]
266
```

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

```
267 local currentformat = "plain"
268 function luamplib.setformat (name)
269   currentformat = name
270 end
271
```

v2.9 has introduced the concept of "code inherit"

```
272 luamplib.codeinherit = false
273 local mplibinstances = {}
274 local has_instancename = false
275
276 local function reporterror (result, prevlog)
277   if not result then
278     err("no result object returned")
279   else
280     local t, e, l = result.term, result.error, result.log
```

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

```
    local log = l or t or "no-term"
    log = log:gsub("%(Please type a command or say `end'%)",""):gsub("\n+","\n")
    if result.status > 0 then
      local first = log:match"(.-\n! .-)\n! "
      if first then
        termorlog("term", first)
        termorlog("log", log, "Warning")
      else
        warn(log)
      end
      if result.status > 1 then
        err(e or "see above messages")
      end
    elseif prevlog then
      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 but just prints an info, even if output has no figure.

```
      local show = log:match"\n>>? .+"
      if show then
        termorlog("term", show, "Info (more info in the log)")
        info(log)
      elseif luamplib.showlog and log:find"%g" then
        info(log)
      end
    end
    return log
  end
end

local function luamplibload (name)
  local mpx = mplib.new {
    ini_version = true,
    find_file   = luamplib.finder,
```

Make use of make_text and run_script, which will co-operate with LuaTEX's tex.runtoks. And we provide numbersystem option since v2.4. Default value "scaled" can be changed by declaring \mplibnumbersystem{double} or \mplibnumbersystem{decimal}. See https://github.com/lualatex/luamplib/issues/21.

```
    make_text   = luamplib.maketext,
    run_script  = luamplib.runscript,
    math_mode   = luamplib.numbersystem,
    job_name    = tex.jobname,
    random_seed = math.random(4095),
    extensions  = 1,
  }
```

Append our own MetaPost preamble to the preamble above.

```
  local preamble = tableconcat{
    format(preamble, replacesuffix(name,"mp")),
    luamplib.preambles.mplibcode,
    luamplib.legacy_verbatimtex and luamplib.preambles.legacyverbatimtex or "",
    luamplib.textextlabel and luamplib.preambles.textextlabel or "",
  }
```

```
  local result, log
  if not mpx then
    result = { status = 99, error = "out of memory"}
  else
    result = mpx:execute(preamble)
  end
  log = reporterror(result)
  return mpx, result, log
end

```

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

```
local function process (data, instancename)
```

The workaround of issue #70 seems to be unnecessary, as we use make_text now.

```
  if not data:find(name_b.."beginfig%s*%([%+%-%s]*%d[%.%d%s]*%)") then
    data = data .. "beginfig(-1);endfig;"
  end
```

```
  local currfmt
  if instancename and instancename ~= "" then
    currfmt = instancename
    has_instancename = true
  else
    currfmt = tableconcat{
      currentformat,
      luamplib.numbersystem or "scaled",
      tostring(luamplib.textextlabel),
      tostring(luamplib.legacy_verbatimtex),
    }
    has_instancename = false
  end
  local mpx = mplibinstances[currfmt]
  local standalone = not (has_instancename or luamplib.codeinherit)
  if mpx and standalone then
    mpx:finish()
  end
  local log = ""
  if standalone or not mpx then
    mpx, _, log = luamplibload(currentformat)
    mplibinstances[currfmt] = mpx
  end
  local converted, result = false, {}
  if mpx and data then
    result = mpx:execute(data)
    local log = reporterror(result, log)
    if log then
      if result.fig then
        converted = luamplib.convert(result)
      else
        info"No figure output. Maybe no beginfig/endfig"
      end
    end
  else
```

```
    err"Mem file unloadable. Maybe generated with a different version of mplib?"
  end
  return converted, result
end

```

dvipdfmx is supported, though nobody seems to use it.

```
local pdfmode = tex.outputmode > 0
```

make_text and some run_script uses LuaTEX's tex.runtoks, which made possible running TEX code snippets inside \directlua.

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

```

tex.scantoks sometimes fail to read catcode properly, especially \#, \&, or \%. After some experiment, we dropped using it. Instead, a function containing tex.script seems to work nicely.

```
local function run_tex_code_no_use (str, cat)
  cat = cat or catlatex
  texscantoks("mplibtmptoks", cat, str)
  texruntoks("mplibtmptoks")
end


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

```

Prepare textext box number containers, locals, globals and possibly instances. 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 declared as true. Boxes of an instance will also be global, so that their tex boxes can be shared among instances of the same name.

```
local texboxes = { globalid = 0, localid = 4096 }
```

For conversion of sp to bp.

```
local factor = 65536*(7227/7200)

local textext_fmt = 'image(addto currentpicture doublepath unitsquare \z
xscaled %f yscaled %f shifted (0,-%f) \z
withprescript "mplibtexboxid=%i:%f:%f")'

local function process_tex_text (str)
  if str then
    local global = (has_instancename or luamplib.globaltextext or luamplib.codeinherit)
                   and "\\global" or ""
    local tex_box_id
    if global == "" then
      tex_box_id = texboxes.localid + 1
      texboxes.localid = tex_box_id
    else
      local boxid = texboxes.globalid + 1
      texboxes.globalid = boxid
```

```
      run_tex_code(format(
        [[\expandafter\newbox\csname luamplib.box.%s\endcsname]], boxid))
      tex_box_id = tex.getcount'allocationnumber'
    end
    run_tex_code(format("%s\\setbox%i\\hbox{%s}", global, tex_box_id, str))
    local box = texgetbox(tex_box_id)
    local wd  = box.width  / factor
    local ht  = box.height / factor
    local dp  = box.depth  / factor
    return textext_fmt:format(wd, ht+dp, dp, tex_box_id, wd, ht+dp)
  end
  return ""
end
```

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.

```
local mplibcolorfmt = {
  xcolor = tableconcat{
    [[\begingroup\let\XC@mcolor\relax]],
    [[\def\set@color{\global\mplibtmptoks\expandafter{\current@color}}]],
    [[\color%s\endgroup]],
  },
  l3color = tableconcat{
    [[\begingroup\def\__color_select:N#1{\expandafter\__color_select:nn#1}]],
    [[\def\__color_backend_select:nn#1#2{\global\mplibtmptoks{#1 #2}}]],
    [[\def\__kernel_backend_literal:e#1{\global\mplibtmptoks\expandafter{\expanded{#1}}}]],
    [[\color_select:n%s\endgroup]],
  },
}

local colfmt = is_defined'color_select:n' and "l3color" or "xcolor"
if colfmt == "l3color" then
  run_tex_code{
    "\\newcatcodetable\\luamplibcctabexplat",
    "\\begingroup",
    "\\catcode`@=11 ",
    "\\catcode`_=11 ",
    "\\catcode`:=11 ",
    "\\savecatcodetable\\luamplibcctabexplat",
    "\\endgroup",
  }
end
local ccexplat = luatexbase.registernumber"luamplibcctabexplat"

local function process_color (str)
  if str then
    if not str:find("%b{}") then
      str = format("{%s}",str)
    end
    local myfmt = mplibcolorfmt[colfmt]
    if colfmt == "l3color" and is_defined"color" then
      if str:find("%b[]") then
```

```
      myfmt = mplibcolorfmt.xcolor
    else
      for _,v in ipairs(str:match"{(.+)}":explode"!") do
        if not v:find"^%s*%d+%s*$" then
          local pp = get_macro(format("l__color_named_%s_prop",v))
          if not pp or pp == "" then
            myfmt = mplibcolorfmt.xcolor
            break
          end
        end
      end
    end
    run_tex_code(myfmt:format(str), ccexplat or catat11)
    local t = texgettoks"mplibtmptoks"
    if not pdfmode and not t:find"^pdf" then
      t = t:gsub("%a+ (.+)","pdf:bc [%1]")
    end
    return format('1 withprescript "mpliboverridecolor=%s"', t)
  end
  return ""
end

```

for `\mpdim` or `mplibdimen`

```
local function process_dimen (str)
  if str then
    str = str:gsub("{(.+)}","%1")
    run_tex_code(format([[\mplibtmptoks\expandafter{\the\dimexpr %s\relax}]], str))
    return format("begingroup %s endgroup", texgettoks"mplibtmptoks")
  end
  return ""
end

```

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

```
local function process_verbatimtex_text (str)
  if str then
    run_tex_code(str)
  end
  return ""
end

```

For legacy verbatimtex process. `verbatimtex ... etex` before `beginfig()` is not ignored, but the TEX code is inserted just before the mplib box. And TEX code inside `beginfig() ... endfig` is inserted after the mplib box.

```
local tex_code_pre_mplib = {}
luamplib.figid = 1
luamplib.in_the_fig = false

local function process_verbatimtex_prefig (str)
  if str then
    tex_code_pre_mplib[luamplib.figid] = str
```

```
  end
  return ""
end

local function process_verbatimtex_infig (str)
  if str then
    return format('special "postmplibverbtex=%s";', str)
  end
  return ""
end

local runscript_funcs = {
  luamplibtext    = process_tex_text,
  luamplibcolor   = process_color,
  luamplibdimen   = process_dimen,
  luamplibprefig  = process_verbatimtex_prefig,
  luamplibinfig   = process_verbatimtex_infig,
  luamplibverbtex = process_verbatimtex_text,
}

```

For metafun format. see issue #79.

```
mp = mp or {}
local mp = mp
mp.mf_path_reset = mp.mf_path_reset or function() end
mp.mf_finish_saving_data = mp.mf_finish_saving_data or function() end
mp.report = mp.report or info

```

metafun 2021-03-09 changes crashes luamplib.

```
catcodes = catcodes or {}
local catcodes = catcodes
catcodes.numbers = catcodes.numbers or {}
catcodes.numbers.ctxcatcodes = catcodes.numbers.ctxcatcodes or catlatex
catcodes.numbers.texcatcodes = catcodes.numbers.texcatcodes or catlatex
catcodes.numbers.luacatcodes = catcodes.numbers.luacatcodes or catlatex
catcodes.numbers.notcatcodes = catcodes.numbers.notcatcodes or catlatex
catcodes.numbers.vrbcatcodes = catcodes.numbers.vrbcatcodes or catlatex
catcodes.numbers.prtcatcodes = catcodes.numbers.prtcatcodes or catlatex
catcodes.numbers.txtcatcodes = catcodes.numbers.txtcatcodes or catlatex

```

A function from ConTEXt general.

```
local function mpprint(buffer,...)
  for i=1,select("#",...) do
    local value = select(i,...)
    if value ~= nil then
      local t = type(value)
      if t == "number" then
        buffer[#buffer+1] = format("%.16f",value)
      elseif t == "string" then
        buffer[#buffer+1] = value
      elseif t == "table" then
        buffer[#buffer+1] = "(" .. tableconcat(value,",") .. ")"
      else -- boolean or whatever
```

```
      buffer[#buffer+1] = tostring(value)
    end
  end
end

function luamplib.runscript (code)
  local id, str = code:match("(.-){(.*)}")
  if id and str then
    local f = runscript_funcs[id]
    if f then
      local t = f(str)
      if t then return t end
    end
  end
  local f = loadstring(code)
  if type(f) == "function" then
    local buffer = {}
    function mp.print(...)
      mpprint(buffer,...)
    end
    local res = {f()}
    buffer = tableconcat(buffer)
    if buffer and buffer ~= "" then
      return buffer
    end
    buffer = {}
    mpprint(buffer, table.unpack(res))
    return tableconcat(buffer)
  end
  return ""
end
```

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

```
local function protecttexcontents (str)
  return str:gsub("\\%%", "\0PerCent\0")
            :gsub("%%.-\n", "")
            :gsub("%%.-$",  "")
            :gsub("%zPerCent%z", "\\%%")
            :gsub("%s+", " ")
end

luamplib.legacy_verbatimtex = true

function luamplib.maketext (str, what)
  if str and str ~= "" then
    str = protecttexcontents(str)
    if what == 1 then
      if not str:find("\\documentclass"..name_e) and
         not str:find("\\begin%s*{document}") and
         not str:find("\\documentstyle"..name_e) and
         not str:find("\\usepackage"..name_e) then
        if luamplib.legacy_verbatimtex then
          if luamplib.in_the_fig then
```

```
            return process_verbatimtex_infig(str)
          else
            return process_verbatimtex_prefig(str)
          end
        else
          return process_verbatimtex_text(str)
        end
      end
    else
      return process_tex_text(str)
    end
  end
  return ""
end

```

luamplib's metapost color operators

```
local function colorsplit (res)
  local t, tt = { }, res:gsub("[%[%]]",""):explode()
  local be = tt[1]:find"^%d" and 1 or 2
  for i=be, #tt do
    if tt[i]:find"^%a" then break end
    t[#t+1] = tt[i]
  end
  return t
end

luamplib.gettexcolor = function (str, rgb)
  local res = process_color(str):match'"mpliboverridecolor=(.+)"'
  if res:find" cs " or res:find"@pdf.obj" then
    if not rgb then
      warn("%s is a spot color. Forced to CMYK", str)
    end
    run_tex_code({
      "\\color_export:nnN{",
      str,
      "}{",
      rgb and "space-sep-rgb" or "space-sep-cmyk",
      "}\\mplib_@tempa",
    },ccexplat)
    return get_macro"mplib_@tempa":explode()
  end
  local t = colorsplit(res)
  if #t == 3 or not rgb then return t end
  if #t == 4 then
    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]) }
  end
  return { t[1], t[1], t[1] }
end

luamplib.shadecolor = function (str)
  local res = process_color(str):match'"mpliboverridecolor=(.+)"'
  if res:find" cs " or res:find"@pdf.obj" then -- spot color shade: l3 only
```

An example of spot color shading:

```
\documentclass{article}
\usepackage{luamplib}
\mplibsetformat{metafun}
\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 xyscaled (\mpdim\textwidth,1cm)
       withshademethod "linear"
       withshadevector (0,1)
       withshadestep (
           withshadefraction .5
           withshadecolors ("spotB","spotC")
       )
       withshadestep (
           withshadefraction 1
           withshadecolors ("spotC","spotD")
       )
  ;
endfig;
\end{mplibcode}
\end{document}
```

```
    run_tex_code({
      [[\color_export:nnN{]], str, [[}{backend}\mplib_@tempa]],
    },ccexplat)
    local name = get_macro'mplib_@tempa':match'{(.-)}{.+}'
    local t, obj = res:explode()
    if pdfmode then
```

```
      obj = t[1]:match"^/(.+)"
      if ltx.pdf and ltx.pdf.object_id then
        obj = format("%s 0 R", ltx.pdf.object_id(obj))
      else
        run_tex_code({
          [[\edef\mplib_@tempa{\pdf_object_ref:n{]], obj, "}}",
        },ccexplat)
        obj = get_macro'mplib_@tempa'
      end
    else
      obj = t[2]
    end
    local value = t[3]:match"%[(.-)%]" or t[3]
    return format('(%s) withprescript"mplib_spotcolor=%s:%s"', value,obj,name)
  end
  return colorsplit(res)
end

```

luamplib's mplibgraphictext operator

```
local running = -1073741824
local emboldenfonts = { }
local function getemboldenwidth (curr, fakebold)
  local width = emboldenfonts.width
  if not width then
    local f
    local function getglyph(n)
      while n do
        if n.head then
          getglyph(n.head)
        elseif n.font and n.font > 0 then
          f = n.font; break
        end
        n = node.getnext(n)
      end
    end
    getglyph(curr)
    width = font.getcopy(f or font.current()).size * fakebold / factor * 10
    emboldenfonts.width = width
  end
  return width
end
local function getrulewhatsit (line, wd, ht, dp)
  line, wd, ht, dp = line/1000, wd/factor, ht/factor, dp/factor
  local pl
  local fmt = "%f w %f %f %f %f re %s"
  if pdfmode then
    pl = node.new("whatsit","pdf_literal")
    pl.mode = 0
  else
    fmt = "pdf:content "..fmt
    pl = node.new("whatsit","special")
  end
  pl.data = fmt:format(line, 0, -dp, wd, ht+dp, "B")
```

```
  local ss = node.new"glue"
  node.setglue(ss, 0, 65536, 65536, 2, 2)
  pl.next = ss
  return pl
end
local function getrulemetric (box, curr, bp)
  local wd,ht,dp = curr.width, curr.height, curr.depth
  wd = wd == running and box.width  or wd
  ht = ht == running and box.height or ht
  dp = dp == running and box.depth  or dp
  if bp then
    return wd/factor, ht/factor, dp/factor
  end
  return wd, ht, dp
end
local function embolden (box, curr, fakebold)
  local head = curr
  while curr do
    if curr.head then
      curr.head = embolden(curr, curr.head, fakebold)
    elseif curr.replace then
      curr.replace = embolden(box, curr.replace, fakebold)
    elseif curr.leader then
      if curr.leader.head then
        curr.leader.head = embolden(curr.leader, curr.leader.head, fakebold)
      elseif curr.leader.id == node.id"rule" then
        local glue = node.effective_glue(curr, box)
        local line = getemboldenwidth(curr, fakebold)
        local wd,ht,dp = getrulemetric(box, curr.leader)
        if box.id == node.id"hlist" then
          wd = glue
        else
          ht, dp = 0, glue
        end
        local pl = getrulewhatsit(line, wd, ht, dp)
        local pack = box.id == node.id"hlist" and node.hpack or node.vpack
        local list = pack(pl, glue, "exactly")
        head = node.insert_after(head, curr, list)
        head, curr = node.remove(head, curr)
      end
    elseif curr.id == node.id"rule" and curr.subtype == 0 then
      local line = getemboldenwidth(curr, fakebold)
      local wd,ht,dp = getrulemetric(box, curr)
      if box.id == node.id"vlist" then
        ht, dp = 0, ht+dp
      end
      local pl = getrulewhatsit(line, wd, ht, dp)
      local list
      if box.id == node.id"hlist" then
        list = node.hpack(pl, wd, "exactly")
      else
        list = node.vpack(pl, ht+dp, "exactly")
      end
      head = node.insert_after(head, curr, list)
```

```
    head, curr = node.remove(head, curr)
  elseif curr.id == node.id"glyph" and curr.font > 0 then
    local f = curr.font
    local i = emboldenfonts[f]
    if not i then
      local ft = font.getfont(f) or font.getcopy(f)
      if pdfmode then
        width = ft.size * fakebold / factor * 10
        emboldenfonts.width = width
        ft.mode, ft.width = 2, width
        i = font.define(ft)
      else
        if ft.format ~= "opentype" and ft.format ~= "truetype" then
          goto skip_type1
        end
        local name = ft.name:gsub('"','''):gsub(';$','')
        name = format('%s;embolden=%s;',name,fakebold)
        _, i = fonts.constructors.readanddefine(name,ft.size)
      end
      emboldenfonts[f] = i
    end
    curr.font = i
  end
  ::skip_type1::
  curr = node.getnext(curr)
 end
 return head
end
local function graphictextcolor (col, filldraw)
 if col:find"^[%d%.:]+$" then
   col = col:explode":"
   if pdfmode then
     local op = #col == 4 and "k" or #col == 3 and "rg" or "g"
     col[#col+1] = filldraw == "fill" and op or op:upper()
     return tableconcat(col," ")
   end
   return format("[%s]", tableconcat(col," "))
 end
 col = process_color(col):match'"mpliboverridecolor=(.+)"'
 if pdfmode then
   local t, tt = col:explode(), { }
   local b = filldraw == "fill" and 1 or #t/2+1
   local e = b == 1 and #t/2 or #t
   for i=b,e do
     tt[#tt+1] = t[i]
   end
   return tableconcat(tt," ")
 end
 return col:gsub("^.- ","")
end
luamplib.graphictext = function (text, fakebold, fc, dc)
 local fmt = process_tex_text(text):sub(1,-2)
 local id = tonumber(fmt:match"mplibtexboxid=(%d+):")
 emboldenfonts.width = nil
```

```
  local box = texgetbox(id)
  box.head = embolden(box, box.head, fakebold)
  local fill = graphictextcolor(fc,"fill")
  local draw = graphictextcolor(dc,"draw")
  local bc = pdfmode and "" or "pdf:bc "
  return format('%s withprescript "mpliboverridecolor=%s%s %s")', fmt, bc, fill, draw)
end

```

luamplib's mplibglyph operator

```
local function mperr (str)
  return format("hide(errmessage %q)", str)
end
local function getangle (a,b,c)
  local r = math.deg(math.atan(c.y-b.y, c.x-b.x) - math.atan(b.y-a.y, b.x-a.x))
  if r > 180 then
    r = r - 360
  elseif r < -180 then
    r = r + 360
  end
  return r
end
local function turning (t)
  local r, n = 0, #t
  for i=1,2 do
    tableinsert(t, t[i])
  end
  for i=1,n do
    r = r + getangle(t[i], t[i+1], t[i+2])
  end
  return r/360
end
local function glyphimage(t, fmt)
  local q,p,r = {{},{}}
  for i,v in ipairs(t) do
    local cmd = v[#v]
    if cmd == "m" then
      p = {format('(%s,%s)',v[1],v[2])}
      r = {{x=v[1],y=v[2]}}
    else
      local nt = t[i+1]
      local last = not nt or nt[#nt] == "m"
      if cmd == "l" then
        local pt = t[i-1]
        local seco = pt[#pt] == "m"
        if (last or seco) and r[1].x == v[1] and r[1].y == v[2] then
        else
          tableinsert(p, format('--(%s,%s)',v[1],v[2]))
          tableinsert(r, {x=v[1],y=v[2]})
        end
        if last then
          tableinsert(p, '--cycle')
        end
      elseif cmd == "c" then
        tableinsert(p, format('..controls(%s,%s)and(%s,%s)',v[1],v[2],v[3],v[4]))
```

```
        if last and r[1].x == v[5] and r[1].y == v[6] then
          tableinsert(p, '..cycle')
        else
          tableinsert(p, format('..(%s,%s)',v[5],v[6]))
          if last then
            tableinsert(p, '--cycle')
          end
          tableinsert(r, {x=v[5],y=v[6]})
        end
      else
        return mperr"unknown operator"
      end
      if last then
        tableinsert(q[ turning(r) > 0 and 1 or 2 ], tableconcat(p))
      end
    end
  end
  r = { }
  if fmt == "opentype" then
    for _,v in ipairs(q[1]) do
      tableinsert(r, format('addto currentpicture contour %s;',v))
    end
    for _,v in ipairs(q[2]) do
      tableinsert(r, format('addto currentpicture contour %s withcolor background;',v))
    end
  else
    for _,v in ipairs(q[2]) do
      tableinsert(r, format('addto currentpicture contour %s;',v))
    end
    for _,v in ipairs(q[1]) do
      tableinsert(r, format('addto currentpicture contour %s withcolor background;',v))
    end
  end
  return format('image(%s)', tableconcat(r))
end
if not table.tofile then require"lualibs-lpeg"; require"lualibs-table"; end
function luamplib.glyph (f, c)
  local filename, subfont, instance, kind, shapedata
  local fid = tonumber(f) or font.id(f)
  if fid > 0 then
    local fontdata = font.getfont(fid) or font.getcopy(fid)
    filename, subfont, kind = fontdata.filename, fontdata.subfont, fontdata.format
    instance = fontdata.specification and fontdata.specification.instance
    filename = filename and filename:gsub("^harfloaded:","")
  else
    local name
    f = f:match"^%s*(.+)%s*$"
    name, subfont, instance = f:match"(.+)%((%d+)%)%[(.-)%]$"
    if not name then
      name, instance = f:match"(.+)%[(.-)%]$" -- SourceHanSansK-VF.otf[Heavy]
    end
    if not name then
      name, subfont = f:match"(.+)%((%d+)%)$" -- Times.ttc(2)
    end
```

```
924   name = name or f
925   subfont = (subfont or 0)+1
926   instance = instance and instance:lower()
927   for _,ftype in ipairs{"opentype", "truetype"} do
928     filename = kpse.find_file(name, ftype.." fonts")
929     if filename then
930       kind = ftype; break
931     end
932   end
933 end
934 if kind ~= "opentype" and kind ~= "truetype" then
935   f = fid and fid > 0 and tex.fontname(fid) or f
936   if kpse.find_file(f, "tfm") then
937     return format("glyph %s of %q", tonumber(c) or format("%q",c), f)
938   else
939     return mperr"font not found"
940   end
941 end
942 local time = lfsattributes(filename,"modification")
943 local k = format("shapes_%s(%s)[%s]", filename, subfont or "", instance or "")
944 local h = format(string.rep('%02x', 256/8), string.byte(sha2.digest256(k), 1, -1))
945 local newname = format("%s/%s.lua", cachedir or outputdir, h)
946 local newtime = lfsattributes(newname,"modification") or 0
947 if time == newtime then
948   shapedata = require(newname)
949 end
950 if not shapedata then
951   shapedata = fonts and fonts.handlers.otf.readers.loadshapes(filename,subfont,instance)
952   if not shapedata then return mperr"loadshapes() failed. luaotfload not loaded?" end
953   table.tofile(newname, shapedata, "return")
954   lfstouch(newname, time, time)
955 end
956 local gid = tonumber(c)
957 if not gid then
958   local uni = utf8.codepoint(c)
959   for i,v in pairs(shapedata.glyphs) do
960     if c == v.name or uni == v.unicode then
961       gid = i; break
962     end
963   end
964 end
965 if not gid then return mperr"cannot get GID (glyph id)" end
966 local fac = 1000 / (shapedata.units or 1000)
967 local t = shapedata.glyphs[gid].segments
968 if not t then return "image(fill fullcircle scaled 0;)" end
969 for i,v in ipairs(t) do
970   if type(v) == "table" then
971     for ii,vv in ipairs(v) do
972       if type(vv) == "number" then
973         t[i][ii] = format("%.0f", vv * fac)
974       end
975     end
976   end
977 end
```

```
  kind = shapedata.format or kind
  return glyphimage(t, kind)
end
```

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

```
local rulefmt = "mpliboutlinepic[%i]:=image(addto currentpicture contour \z
unitsquare shifted - center unitsquare;) xscaled %f yscaled %f shifted (%f,%f);"
local outline_horz, outline_vert
function outline_vert (res, box, curr, xshift, yshift)
  local b2u = box.dir == "LTL"
  local dy = (b2u and -box.depth or box.height)/factor
  local ody = dy
  while curr do
    if curr.id == node.id"rule" then
      local wd, ht, dp = getrulemetric(box, curr, true)
      local hd = ht + dp
      if hd ~= 0 then
        dy = dy + (b2u and dp or -ht)
        if wd ~= 0 and curr.subtype == 0 then
          res[#res+1] = rulefmt:format(#res+1, wd, hd, xshift+wd/2, yshift+dy+(ht-dp)/2)
        end
        dy = dy + (b2u and ht or -dp)
      end
    elseif curr.id == node.id"glue" then
      local vwidth = node.effective_glue(curr,box)/factor
      if curr.leader then
        local curr, kind = curr.leader, curr.subtype
        if curr.id == node.id"rule" then
          local wd = getrulemetric(box, curr, true)
          if wd ~= 0 then
            local hd = vwidth
            local dy = dy + (b2u and 0 or -hd)
            if hd ~= 0 and curr.subtype == 0 then
              res[#res+1] = rulefmt:format(#res+1, wd, hd, xshift+wd/2, yshift+dy+hd/2)
            end
          end
        elseif curr.head then
          local hd = (curr.height + curr.depth)/factor
          if hd <= vwidth then
            local dy, n, iy = dy, 0, 0
            if kind == 100 or kind == 103 then -- todo: gleaders
              local ady = abs(ody - dy)
              local ndy = math.ceil(ady / hd) * hd
              local diff = ndy - ady
              n = (vwidth-diff) // hd
              dy = dy + (b2u and diff or -diff)
            else
              n = vwidth // hd
              if kind == 101 then
                local side = vwidth % hd / 2
                dy = dy + (b2u and side or -side)
              elseif kind == 102 then
                iy = vwidth % hd / (n+1)
                dy = dy + (b2u and iy or -iy)
```

```
            end
          end
          dy = dy + (b2u and curr.depth or -curr.height)/factor
          hd = b2u and hd or -hd
          iy = b2u and iy or -iy
          local func = curr.id == node.id"hlist" and outline_horz or outline_vert
          for i=1,n do
            res = func(res, curr, curr.head, xshift+curr.shift/factor, yshift+dy)
            dy = dy + hd + iy
          end
        end
      end
      dy = dy + (b2u and vwidth or -vwidth)
    elseif curr.id == node.id"kern" then
      dy = dy + curr.kern/factor * (b2u and 1 or -1)
    elseif curr.id == node.id"vlist" then
      dy = dy + (b2u and curr.depth or -curr.height)/factor
      res = outline_vert(res, curr, curr.head, xshift+curr.shift/factor, yshift+dy)
      dy = dy + (b2u and curr.height or -curr.depth)/factor
    elseif curr.id == node.id"hlist" then
      dy = dy + (b2u and curr.depth or -curr.height)/factor
      res = outline_horz(res, curr, curr.head, xshift+curr.shift/factor, yshift+dy)
      dy = dy + (b2u and curr.height or -curr.depth)/factor
    end
    curr = node.getnext(curr)
  end
  return res
end
function outline_horz (res, box, curr, xshift, yshift, discwd)
  local r2l = box.dir == "TRT"
  local dx = r2l and (discwd or box.width/factor) or 0
  local dirs = { { dir = r2l, dx = dx } }
  while curr do
    if curr.id == node.id"dir" then
      local sign, dir = curr.dir:match"(.)(...)"
      local level, newdir = curr.level, r2l
      if sign == "+" then
        newdir = dir == "TRT"
        if r2l ~= newdir then
          local n = node.getnext(curr)
          while n do
            if n.id == node.id"dir" and n.level+1 == level then break end
            n = node.getnext(n)
          end
          n = n or node.tail(curr)
          dx = dx + node.rangedimensions(box, curr, n)/factor * (newdir and 1 or -1)
        end
        dirs[level] = { dir = r2l, dx = dx }
      else
        local level = level + 1
        newdir = dirs[level].dir
        if r2l ~= newdir then
          dx = dirs[level].dx
```

```
      end
    end
    r2l = newdir
  elseif curr.char and curr.font and curr.font > 0 then
    local ft = font.getfont(curr.font) or font.getcopy(curr.font)
    local gid = ft.characters[curr.char].index or curr.char
    local scale = ft.size / factor / 1000
    local slant   = (ft.slant or 0)/1000
    local extend  = (ft.extend or 1000)/1000
    local squeeze = (ft.squeeze or 1000)/1000
    local expand  = 1 + (curr.expansion_factor or 0)/1000000
    local xscale = scale * extend * expand
    local yscale = scale * squeeze
    dx = dx - (r2l and curr.width/factor*expand or 0)
    local xpos = dx + xshift + (curr.xoffset or 0)/factor
    local ypos = yshift + (curr.yoffset or 0)/factor
    local vertical = ft.shared and ft.shared.features.vertical and "rotated 90" or ""
    if vertical ~= "" then -- luatexko
      for _,v in ipairs(ft.characters[curr.char].commands or { }) do
        if v[1] == "down" then
          ypos = ypos - v[2] / factor
        elseif v[1] == "right" then
          xpos = xpos + v[2] / factor
        else
          break
        end
      end
    end
    local image
    if ft.format == "opentype" or ft.format == "truetype" then
      image = luamplib.glyph(curr.font, gid)
    else
      local name, scale = ft.name, 1
      local vf = font.read_vf(name, ft.size)
      if vf and vf.characters[gid] then
        local cmds = vf.characters[gid].commands or {}
        for _,v in ipairs(cmds) do
          if v[1] == "char" then
            gid = v[2]
          elseif v[1] == "font" and vf.fonts[v[2]] then
            name  = vf.fonts[v[2]].name
            scale = vf.fonts[v[2]].size / ft.size
          end
        end
      end
      image = format("glyph %s of %q scaled %f", gid, name, scale)
    end
    res[#res+1] = format("mpliboutlinepic[%i]:=%s xscaled %f yscaled %f slanted %f %s shifted (%f,%f);",
                         #res+1, image, xscale, yscale, slant, vertical, xpos, ypos)
    dx = dx + (r2l and 0 or curr.width/factor*expand)
  elseif curr.replace then
    local width = node.dimensions(curr.replace)/factor
    dx = dx - (r2l and width or 0)
    res = outline_horz(res, box, curr.replace, xshift+dx, yshift, width)
```

```
    dx = dx + (r2l and 0 or width)
  elseif curr.id == node.id"rule" then
    local wd, ht, dp = getrulemetric(box, curr, true)
    if wd ~= 0 then
      local hd = ht + dp
      dx = dx - (r2l and wd or 0)
      if hd ~= 0 and curr.subtype == 0 then
        res[#res+1] = rulefmt:format(#res+1, wd, hd, xshift+dx+wd/2, yshift+(ht-dp)/2)
      end
      dx = dx + (r2l and 0 or wd)
    end
  elseif curr.id == node.id"glue" then
    local width = node.effective_glue(curr, box)/factor
    dx = dx - (r2l and width or 0)
    if curr.leader then
      local curr, kind = curr.leader, curr.subtype
      if curr.id == node.id"rule" then
        local wd, ht, dp = getrulemetric(box, curr, true)
        local hd = ht + dp
        if hd ~= 0 then
          wd = width
          if wd ~= 0 and curr.subtype == 0 then
            res[#res+1] = rulefmt:format(#res+1, wd, hd, xshift+dx+wd/2, yshift+(ht-dp)/2)
          end
        end
      elseif curr.head then
        local wd = curr.width/factor
        if wd <= width then
          local dx = r2l and dx+width or dx
          local n, ix = 0, 0
          if kind == 100 or kind == 103 then -- todo: gleaders
            local adx = abs(dx-dirs[1].dx)
            local ndx = math.ceil(adx / wd) * wd
            local diff = ndx - adx
            n = (width-diff) // wd
            dx = dx + (r2l and -diff-wd or diff)
          else
            n = width // wd
            if kind == 101 then
              local side = width % wd /2
              dx = dx + (r2l and -side-wd or side)
            elseif kind == 102 then
              ix = width % wd / (n+1)
              dx = dx + (r2l and -ix-wd or ix)
            end
          end
          wd = r2l and -wd or wd
          ix = r2l and -ix or ix
          local func = curr.id == node.id"hlist" and outline_horz or outline_vert
          for i=1,n do
            res = func(res, curr, curr.head, xshift+dx, yshift-curr.shift/factor)
            dx = dx + wd + ix
          end
        end
```

```
      end
    end
    dx = dx + (r2l and 0 or width)
  elseif curr.id == node.id"kern" then
    dx = dx + curr.kern/factor * (r2l and -1 or 1)
  elseif curr.id == node.id"math" then
    dx = dx + curr.surround/factor * (r2l and -1 or 1)
  elseif curr.id == node.id"vlist" then
    dx = dx - (r2l and curr.width/factor or 0)
    res = outline_vert(res, curr, curr.head, xshift+dx, yshift-curr.shift/factor)
    dx = dx + (r2l and 0 or curr.width/factor)
  elseif curr.id == node.id"hlist" then
    dx = dx - (r2l and curr.width/factor or 0)
    res = outline_horz(res, curr, curr.head, xshift+dx, yshift-curr.shift/factor)
    dx = dx + (r2l and 0 or curr.width/factor)
  end
  curr = node.getnext(curr)
 end
 return res
end
function luamplib.outlinetext (text)
 local fmt = process_tex_text(text)
 local id  = tonumber(fmt:match"mplibtexboxid=(%d+):")
 local box = texgetbox(id)
 local res = outline_horz({ }, box, box.head, 0, 0)
 if #res == 0 then res = { "mpliboutlinepic[1]:=image(fill fullcircle scaled 0;);" } end
 return tableconcat(res) .. format("mpliboutlinenum:=%i;", #res)
end

```

Our MetaPost preambles

```
luamplib.preambles = {
 mplibcode = [[
texscriptmode := 2;
def rawtextext (expr t) = runscript("luamplibtext{"&t&"}") enddef;
def mplibcolor (expr t) = runscript("luamplibcolor{"&t&"}") enddef;
def mplibdimen (expr t) = runscript("luamplibdimen{"&t&"}") enddef;
def VerbatimTeX (expr t) = runscript("luamplibverbtex{"&t&"}") enddef;
if known context_mlib:
 defaultfont := "cmtt10";
 let infont = normalinfont;
 let fontsize = normalfontsize;
 vardef thelabel@#(expr p,z) =
   if string p :
     thelabel@#(p infont defaultfont scaled defaultscale,z)
   else :
     p shifted (z + labeloffset*mfun_laboff@# -
       (mfun_labxf@#*lrcorner p + mfun_labyf@#*ulcorner p +
       (1-mfun_labxf@#-mfun_labyf@#)*llcorner p))
   fi
 enddef;
else:
 vardef textext@# (text t) = rawtextext (t) enddef;
 def message expr t =
   if string t: runscript("mp.report[=["&t&"]=]") else: errmessage "Not a string" fi
```

```
  enddef;
fi
def resolvedcolor(expr s) =
  runscript("return luamplib.shadecolor('"& s &"')")
enddef;
def colordecimals primary c =
  if cmykcolor c:
    decimal cyanpart c & ":" & decimal magentapart c & ":" &
    decimal yellowpart c & ":" & decimal blackpart c
  elseif rgbcolor c:
    decimal redpart c & ":" & decimal greenpart c & ":" & decimal bluepart c
  elseif string c:
    if known graphictextpic: c else: colordecimals resolvedcolor(c) fi
  else:
    decimal c
  fi
enddef;
def externalfigure primary filename =
  draw rawtextext("\includegraphics{"& filename &"}")
enddef;
def TEX = textext enddef;
def mplibtexcolor primary c =
  runscript("return luamplib.gettexcolor('"& c &"')")
enddef;
def mplibrgbtexcolor primary c =
  runscript("return luamplib.gettexcolor('"& c &"','rgb')")
enddef;
def mplibgraphictext primary t =
  begingroup;
  mplibgraphictext_ (t)
enddef;
def mplibgraphictext_ (expr t) text rest =
  save fakebold, scale, fillcolor, drawcolor, withfillcolor, withdrawcolor,
    fb, fc, dc, graphictextpic;
  picture graphictextpic; graphictextpic := nullpicture;
  numeric fb; string fc, dc; fb:=2; fc:="white"; dc:="black";
  let scale = scaled;
  def fakebold  primary c = hide(fb:=c;) enddef;
  def fillcolor primary c = hide(fc:=colordecimals c;) enddef;
  def drawcolor primary c = hide(dc:=colordecimals c;) enddef;
  let withfillcolor = fillcolor; let withdrawcolor = drawcolor;
  addto graphictextpic doublepath origin rest; graphictextpic:=nullpicture;
  def fakebold  primary c = enddef;
  let fillcolor = fakebold; let drawcolor = fakebold;
  let withfillcolor = fillcolor; let withdrawcolor = drawcolor;
  image(draw runscript("return luamplib.graphictext([===["&t&"]===],"
    & decimal fb &",'"& fc &"','"& dc &"')") rest;)
  endgroup;
enddef;
def mplibglyph expr c of f =
  runscript (
    "return luamplib.glyph('"
    & if numeric f: decimal fi f
    & "','"
```

```
    & if numeric c: decimal fi c
    & "')"
  )
enddef;
def mplibdrawglyph expr g =
  draw image(
    save i; numeric i; i:=0;
    for item within g:
      i := i+1;
      fill pathpart item
      if i < length g: withpostscript "collect" fi;
    endfor
  )
enddef;
def mplib_do_outline_text_set_b (text f) (text d) text r =
  def mplib_do_outline_options_f = f enddef;
  def mplib_do_outline_options_d = d enddef;
  def mplib_do_outline_options_r = r enddef;
enddef;
def mplib_do_outline_text_set_f (text f) text r =
  def mplib_do_outline_options_f = f enddef;
  def mplib_do_outline_options_r = r enddef;
enddef;
def mplib_do_outline_text_set_u (text f) text r =
  def mplib_do_outline_options_f = f enddef;
enddef;
def mplib_do_outline_text_set_d (text d) text r =
  def mplib_do_outline_options_d = d enddef;
  def mplib_do_outline_options_r = r enddef;
enddef;
def mplib_do_outline_text_set_r (text d) (text f) text r =
  def mplib_do_outline_options_d = d enddef;
  def mplib_do_outline_options_f = f enddef;
  def mplib_do_outline_options_r = r enddef;
enddef;
def mplib_do_outline_text_set_n text r =
  def mplib_do_outline_options_r = r enddef;
enddef;
def mplib_do_outline_text_set_p = enddef;
def mplib_fill_outline_text =
  for n=1 upto mpliboutlinenum:
    i:=0;
    for item within mpliboutlinepic[n]:
      i:=i+1;
      fill pathpart item mplib_do_outline_options_f withpen pencircle scaled 0
      if (n<mpliboutlinenum) or (i<length mpliboutlinepic[n]): withpostscript "collect"; fi
    endfor
  endfor
enddef;
def mplib_draw_outline_text =
  for n=1 upto mpliboutlinenum:
    for item within mpliboutlinepic[n]:
      draw pathpart item mplib_do_outline_options_d;
    endfor
```

```
  endfor
enddef;
def mplib_filldraw_outline_text =
  for n=1 upto mpliboutlinenum:
    i:=0;
    for item within mpliboutlinepic[n]:
      i:=i+1;
      if (n<mpliboutlinenum) or (i<length mpliboutlinepic[n]):
        fill pathpart item mplib_do_outline_options_f withpostscript "collect";
      else:
        draw pathpart item mplib_do_outline_options_f withpostscript "both";
      fi
    endfor
  endfor
enddef;
vardef mpliboutlinetext@# (expr t) text rest =
  save kind; string kind; kind := str @#;
  save i; numeric i;
  picture mpliboutlinepic[]; numeric mpliboutlinenum;
  def mplib_do_outline_options_d = enddef;
  def mplib_do_outline_options_f = enddef;
  def mplib_do_outline_options_r = enddef;
  runscript("return luamplib.outlinetext[===["&t&"]===]");
  image ( addto currentpicture also image (
    if kind = "f":
      mplib_do_outline_text_set_f rest;
      mplib_fill_outline_text;
    elseif kind = "d":
      mplib_do_outline_text_set_d rest;
      mplib_draw_outline_text;
    elseif kind = "b":
      mplib_do_outline_text_set_b rest;
      mplib_fill_outline_text;
      mplib_draw_outline_text;
    elseif kind = "u":
      mplib_do_outline_text_set_u rest;
      mplib_filldraw_outline_text;
    elseif kind = "r":
      mplib_do_outline_text_set_r rest;
      mplib_draw_outline_text;
      mplib_fill_outline_text;
    elseif kind = "p":
      mplib_do_outline_text_set_p;
      mplib_draw_outline_text;
    else:
      mplib_do_outline_text_set_n rest;
      mplib_fill_outline_text;
    fi;
  ) mplib_do_outline_options_r; )
enddef ;
primarydef t withpattern p =
  image( fill t withprescript "mplibpattern=" & if numeric p: decimal fi p; )
enddef;
]],
```

```
  legacyverbatimtex = [[
def specialVerbatimTeX (text t) = runscript("luamplibprefig{"&t&"}") enddef;
def normalVerbatimTeX  (text t) = runscript("luamplibinfig{"&t&"}") enddef;
let VerbatimTeX = specialVerbatimTeX;
extra_beginfig := extra_beginfig & " let VerbatimTeX = normalVerbatimTeX;"&
  "runscript(" &ditto& "luamplib.in_the_fig=true" &ditto& ");";
extra_endfig := extra_endfig & " let VerbatimTeX = specialVerbatimTeX;"&
  "runscript(" &ditto&
  "if luamplib.in_the_fig then luamplib.figid=luamplib.figid+1 end "&
  "luamplib.in_the_fig=false" &ditto& ");";
]],
  textextlabel = [[
primarydef s infont f = rawtextext(s) enddef;
def fontsize expr f =
  begingroup
  save size; numeric size;
  size := mplibdimen("1em");
  if size = 0: 10pt else: size fi
  endgroup
enddef;
]],
}
```

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

```
luamplib.verbatiminput = false
```

Do not expand `btex ... etex`, `verbatimtex ... etex`, and string expressions.

```
local function protect_expansion (str)
  if str then
    str = str:gsub("\\","!!!Control!!!")
              :gsub("%%","!!!Comment!!!")
              :gsub("#", "!!!HashSign!!!")
              :gsub("{", "!!!LBrace!!!")
              :gsub("}", "!!!RBrace!!!")
    return format("\\unexpanded{%s}",str)
  end
end

local function unprotect_expansion (str)
  if str then
    return str:gsub("!!!Control!!!", "\\")
              :gsub("!!!Comment!!!", "%%")
              :gsub("!!!HashSign!!!","#")
              :gsub("!!!LBrace!!!",  "{")
              :gsub("!!!RBrace!!!",  "}")
  end
end

luamplib.everymplib    = setmetatable({ [""] = "" },{ __index = function(t) return t[""] end })
luamplib.everyendmplib = setmetatable({ [""] = "" },{ __index = function(t) return t[""] end })

function luamplib.process_mplibcode (data, instancename)
  texboxes.localid = 4096
```

```

```

This is needed for legacy behavior

```
  if luamplib.legacy_verbatimtex then
    luamplib.figid, tex_code_pre_mplib = 1, {}
  end

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

```

These five lines are needed for `mplibverbatim` mode.

```
  if luamplib.verbatiminput then
    data = data:gsub("\\mpcolor%s+(.-%b{})","mplibcolor(\"%1\")")
    :gsub("\\mpdim%s+(%b{})", "mplibdimen(\"%1\")")
    :gsub("\\mpdim%s+(\\%a+)","mplibdimen(\"%1\")")
    :gsub(btex_etex, "btex %1 etex ")
    :gsub(verbatimtex_etex, "verbatimtex %1 etex;")
```

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.

```
  else
    data = data:gsub(btex_etex, function(str)
      return format("btex %s etex ", protect_expansion(str)) -- space
    end)
    :gsub(verbatimtex_etex, function(str)
      return format("verbatimtex %s etex;", protect_expansion(str)) -- semicolon
    end)
    :gsub("\".-\"", protect_expansion)
    :gsub("\\%%", "\0PerCent\0")
    :gsub("%%.-\n","\n")
    :gsub("%zPerCent%z", "\\%%")
    run_tex_code(format("\\mplibtmptoks\\expandafter{\\expanded{%s}}",data))
    data = texgettoks"mplibtmptoks"
```

Next line to address issue #55

```
    :gsub("##", "#")
    :gsub("\".-\"", unprotect_expansion)
    :gsub(btex_etex, function(str)
      return format("btex %s etex", unprotect_expansion(str))
    end)
    :gsub(verbatimtex_etex, function(str)
      return format("verbatimtex %s etex", unprotect_expansion(str))
    end)
  end

  process(data, instancename)
end

```

For parsing `prescript` materials.

```
local further_split_keys = {
  mplibtexboxid = true,
  sh_color_a    = true,
```

```
  sh_color_b    = true,
}
local function script2table(s)
  local t = {}
  for _,i in ipairs(s:explode("\13+")) do
    local k,v = i:match("(.-)=(.*)") -- v may contain = or empty.
    if k and v and k ~= "" and not t[k] then
      if further_split_keys[k] or further_split_keys[k:sub(1,10)] then
        t[k] = v:explode(":")
      else
        t[k] = v
      end
    end
  end
  return t
end

```

Codes below for inserting PDF lieterals are mostly from ConTeXt general, with small changes when needed.

```
local function getobjects(result,figure,f)
  return figure:objects()
end

function luamplib.convert (result, flusher)
  luamplib.flush(result, flusher)
  return true -- done
end

local figcontents = { post = { } }
local function put2output(a,...)
  figcontents[#figcontents+1] = type(a) == "string" and format(a,...) or a
end

local function pdf_startfigure(n,llx,lly,urx,ury)
  put2output("\\mplibstarttoPDF{%f}{%f}{%f}{%f}",llx,lly,urx,ury)
end

local function pdf_stopfigure()
  put2output("\\mplibstoptoPDF")
end

```

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

```
local function pdf_literalcode (fmt,...)
  put2output{-2, format(fmt,...)}
end

local function pdf_textfigure(font,size,text,width,height,depth)
  text = text:gsub(".",function(c)
    return format("\\hbox{\\char%i}",string.byte(c)) -- kerning happens in metapost : false
  end)
  put2output("\\mplibtextext{%s}{%f}{%s}{%s}{%s}",font,size,text,0,0)
end
```

```
1553
1554 local bend_tolerance = 131/65536
1555
1556 local rx, sx, sy, ry, tx, ty, divider = 1, 0, 0, 1, 0, 0, 1
1557
1558 local function pen_characteristics(object)
1559   local t = mplib.pen_info(object)
1560   rx, ry, sx, sy, tx, ty = t.rx, t.ry, t.sx, t.sy, t.tx, t.ty
1561   divider = sx*sy - rx*ry
1562   return not (sx==1 and rx==0 and ry==0 and sy==1 and tx==0 and ty==0), t.width
1563 end
1564
1565 local function concat(px, py) -- no tx, ty here
1566   return (sy*px-ry*py)/divider,(sx*py-rx*px)/divider
1567 end
1568
1569 local function curved(ith,pth)
1570   local d = pth.left_x - ith.right_x
1571   if abs(ith.right_x - ith.x_coord - d) <= bend_tolerance and abs(pth.x_coord - pth.left_x - d) <= bend_tolerance t
1572     d = pth.left_y - ith.right_y
1573     if abs(ith.right_y - ith.y_coord - d) <= bend_tolerance and abs(pth.y_coord - pth.left_y - d) <= bend_tolerance
1574       return false
1575     end
1576   end
1577   return true
1578 end
1579
1580 local function flushnormalpath(path,open)
1581   local pth, ith
1582   for i=1,#path do
1583     pth = path[i]
1584     if not ith then
1585       pdf_literalcode("%f %f m",pth.x_coord,pth.y_coord)
1586     elseif curved(ith,pth) then
1587       pdf_literalcode("%f %f %f %f %f %f c",ith.right_x,ith.right_y,pth.left_x,pth.left_y,pth.x_coord,pth.y_coord)
1588     else
1589       pdf_literalcode("%f %f l",pth.x_coord,pth.y_coord)
1590     end
1591     ith = pth
1592   end
1593   if not open then
1594     local one = path[1]
1595     if curved(pth,one) then
1596       pdf_literalcode("%f %f %f %f %f %f c",pth.right_x,pth.right_y,one.left_x,one.left_y,one.x_coord,one.y_coord )
1597     else
1598       pdf_literalcode("%f %f l",one.x_coord,one.y_coord)
1599     end
1600   elseif #path == 1 then -- special case .. draw point
1601     local one = path[1]
1602     pdf_literalcode("%f %f l",one.x_coord,one.y_coord)
1603   end
1604 end
1605
1606 local function flushconcatpath(path,open)
```

```
  pdf_literalcode("%f %f %f %f %f %f cm", sx, rx, ry, sy, tx ,ty)
  local pth, ith
  for i=1,#path do
    pth = path[i]
    if not ith then
      pdf_literalcode("%f %f m",concat(pth.x_coord,pth.y_coord))
    elseif curved(ith,pth) then
      local a, b = concat(ith.right_x,ith.right_y)
      local c, d = concat(pth.left_x,pth.left_y)
      pdf_literalcode("%f %f %f %f %f %f c",a,b,c,d,concat(pth.x_coord, pth.y_coord))
    else
      pdf_literalcode("%f %f l",concat(pth.x_coord, pth.y_coord))
    end
    ith = pth
  end
  if not open then
    local one = path[1]
    if curved(pth,one) then
      local a, b = concat(pth.right_x,pth.right_y)
      local c, d = concat(one.left_x,one.left_y)
      pdf_literalcode("%f %f %f %f %f %f c",a,b,c,d,concat(one.x_coord, one.y_coord))
    else
      pdf_literalcode("%f %f l",concat(one.x_coord,one.y_coord))
    end
  elseif #path == 1 then -- special case .. draw point
    local one = path[1]
    pdf_literalcode("%f %f l",concat(one.x_coord,one.y_coord))
  end
end

local function start_pdf_code()
  if pdfmode then
    pdf_literalcode("q")
  else
    put2output"\\special{pdf:bcontent}"
  end
end
local function stop_pdf_code()
  if pdfmode then
    pdf_literalcode("Q")
  else
    put2output"\\special{pdf:econtent}"
  end
end

```

Now we process hboxes created from btex ... etex or textext(...) or TEX(...), all being the same internally.

```
local function put_tex_boxes (object,prescript)
  local box = prescript.mplibtexboxid
  local n,tw,th = box[1],tonumber(box[2]),tonumber(box[3])
  if n and tw and th then
    local op = object.path
    local first, second, fourth = op[1], op[2], op[4]
```

```
    local tx, ty = first.x_coord, first.y_coord
    local sx, rx, ry, sy = 1, 0, 0, 1
    if tw ~= 0 then
      sx = (second.x_coord - tx)/tw
      rx = (second.y_coord - ty)/tw
      if sx == 0 then sx = 0.00001 end
    end
    if th ~= 0 then
      sy = (fourth.y_coord - ty)/th
      ry = (fourth.x_coord - tx)/th
      if sy == 0 then sy = 0.00001 end
    end
    start_pdf_code()
    pdf_literalcode("%f %f %f %f %f %f cm",sx,rx,ry,sy,tx,ty)
    put2output("\\mplibputtextbox{%i}",n)
    stop_pdf_code()
  end
end

```

Colors

```
local prev_override_color
local function do_preobj_CR(object,prescript)
  if object.postscript == "collect" then return end
  local override = prescript and prescript.mpliboverridecolor
  if override then
    if pdfmode then
      pdf_literalcode(override)
      override = nil
    else
      put2output("\\special{%s}",override)
      prev_override_color = override
    end
  else
    local cs = object.color
    if cs and #cs > 0 then
      pdf_literalcode(luamplib.colorconverter(cs))
      prev_override_color = nil
    elseif not pdfmode then
      override = prev_override_color
      if override then
        put2output("\\special{%s}",override)
      end
    end
  end
  return override
end

```

For transparency and shading

```
local pdfmanagement = is_defined'pdfmanagement_add:nnn'
local pdfobjs, pdfetcs = {}, {}
pdfetcs.pgfextgs = "pgf@sys@addpdfresource@extgs@plain"

local function update_pdfobjs (os)
```

```
  local on = pdfobjs[os]
  if on then
    return on,false
  end
  if pdfmode then
    on = pdf.immediateobj(os)
  else
    on = pdfetcs.cnt or 1
    texsprint(format("\\special{pdf:obj @mplibpdfobj%s %s}",on,os))
    pdfetcs.cnt = on + 1
  end
  pdfobjs[os] = on
  return on,true
end

if pdfmode then
  pdfetcs.getpageres = pdf.getpageresources or function() return pdf.pageresources end
  pdfetcs.setpageres = pdf.setpageresources or function(s) pdf.pageresources = s end
  pdfetcs.initialize_resources = function (name)
    local tabname = format("%s_res",name)
    pdfetcs[tabname] = { }
    if luatexbase.callbacktypes.finish_pdffile then -- ltluatex
      local obj = pdf.reserveobj()
      pdfetcs.setpageres(format("%s/%s %i 0 R", pdfetcs.getpageres() or "", name, obj))
      luatexbase.add_to_callback("finish_pdffile", function()
        pdf.immediateobj(obj, format("<<%s>>", tableconcat(pdfetcs[tabname])))
      end,
      format("luamplib.%s.finish_pdffile",name))
    end
  end
  pdfetcs.fallback_update_resources = function (name, res)
    if luatexbase.callbacktypes.finish_pdffile then
      local t = pdfetcs[format("%s_res",name)]
      t[#t+1] = res
    else
      local tpr, n = pdfetcs.getpageres() or "", 0
      tpr, n = tpr:gsub(format("/%s<<",name), "%1"..res)
      if n == 0 then
        tpr = format("%s/%s<<%s>>", tpr, name, res)
      end
      pdfetcs.setpageres(tpr)
    end
  end
else
  texsprint("\\special{pdf:obj @MPlibTr<<>>}","\\special{pdf:obj @MPlibSh<<>>}",
  "\\special{pdf:obj @MPlibCS<<>>}","\\special{pdf:obj @MPlibPt<<>>}")
end
```

Transparency

```
local transparancy_modes = { [0] = "Normal",
  "Normal",       "Multiply",     "Screen",       "Overlay",
  "SoftLight",    "HardLight",    "ColorDodge",   "ColorBurn",
  "Darken",       "Lighten",      "Difference",   "Exclusion",
  "Hue",          "Saturation",   "Color",        "Luminosity",
```

```
  "Compatible",
}

local function update_tr_res(mode,opaq)
  if pdfetcs.pgfloaded == nil then
    pdfetcs.pgfloaded = is_defined(pdfetcs.pgfextgs)
    if pdfmode and not pdfmanagement and not pdfetcs.pgfloaded and not is_defined"TRP@list" then
      pdfetcs.initialize_resources"ExtGState"
    end
  end
  local os = format("<</BM /%s/ca %.3f/CA %.3f/AIS false>>",mode,opaq,opaq)
  local on, new = update_pdfobjs(os)
  if not new then return on end
  local key = format("MPlibTr%s", on)
  local val = format(pdfmode and "%s 0 R" or "@mplibpdfobj%s", on)
  if pdfmanagement then
    texsprint(ccexplat,
    format("\\pdfmanagement_add:nnn{Page/Resources/ExtGState}{%s}{%s}", key, val))
  else
    local tr = format("/%s %s", key, val)
    if pdfetcs.pgfloaded then
      texsprint(format("\\csname %s\\endcsname{%s}", pdfetcs.pgfextgs,tr))
    elseif pdfmode then
      if is_defined"TRP@list" then
        texsprint(catat11,{
          [[\if@filesw\immediate\write\@auxout{]],
          [[\string\g@addto@macro\string\TRP@list{]],
          tr,
          [[}\fi]],
        })
        if not get_macro"TRP@list":find(tr) then
          texsprint(catat11,[[\global\TRP@reruntrue]])
        end
      else
        pdfetcs.fallback_update_resources("ExtGState", tr)
      end
    else
      texsprint(format("\\special{pdf:put @MPlibTr<<%s>>}",tr))
      texsprint"\\special{pdf:put @resources<</ExtGState @MPlibTr>>}"
    end
  end
  return on
end

local function do_preobj_TR(object,prescript)
  if object.postscript == "collect" then return end
  local opaq = prescript and prescript.tr_transparency
  local tron_no
  if opaq then
    local mode = prescript.tr_alternative or 1
    mode = transparancy_modes[tonumber(mode)]
    tron_no = update_tr_res(mode, opaq)
    start_pdf_code()
    pdf_literalcode("/MPlibTr%i gs",tron_no)
```

```
  end
  return tron_no
end
```

Shading with metafun format.

```
local function sh_pdfpageresources(shtype,domain,colorspace,ca,cb,coordinates,steps,fractions)
  if pdfmode and not pdfmanagement and not pdfetcs.Shading_res then
    pdfetcs.initialize_resources"Shading"
  end
  local fun2fmt,os = "<</FunctionType 2/Domain [%s]/C0 [%s]/C1 [%s]/N 1>>"
  if steps > 1 then
    local list,bounds,encode = { },{ },{ }
    for i=1,steps do
      if i < steps then
        bounds[i] = fractions[i] or 1
      end
      encode[2*i-1] = 0
      encode[2*i]   = 1
      os = fun2fmt:format(domain,tableconcat(ca[i],' '),tableconcat(cb[i],' '))
      list[i] = format(pdfmode and "%s 0 R" or "@mplibpdfobj%s",update_pdfobjs(os))
    end
    os = tableconcat {
      "<</FunctionType 3",
      format("/Bounds [%s]",    tableconcat(bounds,' ')),
      format("/Encode [%s]",    tableconcat(encode,' ')),
      format("/Functions [%s]", tableconcat(list,  ' ')),
      format("/Domain [%s]>>",  domain),
    }
  else
    os = fun2fmt:format(domain,tableconcat(ca[1],' '),tableconcat(cb[1],' '))
  end
  local objref = format(pdfmode and "%s 0 R" or "@mplibpdfobj%s",update_pdfobjs(os))
  os = tableconcat {
    format("<</ShadingType %i", shtype),
    format("/ColorSpace %s",    colorspace),
    format("/Function %s",      objref),
    format("/Coords [%s]",      coordinates),
    "/Extend [true true]/AntiAlias true>>",
  }
  local on, new = update_pdfobjs(os)
  if not new then return on end
  local key = format("MPlibSh%s", on)
  local val = format(pdfmode and "%s 0 R" or "@mplibpdfobj%s", on)
  if pdfmanagement then
    texsprint(ccexplat,
    format("\\pdfmanagement_add:nnn{Page/Resources/Shading}{%s}{%s}", key, val))
  else
    local res = format("/%s %s", key, val)
    if pdfmode then
      pdfetcs.fallback_update_resources("Shading", res)
    else
      texsprint(format("\\special{pdf:put @MPlibSh<<%s>>}", res))
      texsprint"\\special{pdf:put @resources<</Shading @MPlibSh>>}"
    end
```

```
  end
  return on
end

local function color_normalize(ca,cb)
  if #cb == 1 then
    if #ca == 4 then
      cb[1], cb[2], cb[3], cb[4] = 0, 0, 0, 1-cb[1]
    else -- #ca = 3
      cb[1], cb[2], cb[3] = cb[1], cb[1], cb[1]
    end
  elseif #cb == 3 then -- #ca == 4
    cb[1], cb[2], cb[3], cb[4] = 1-cb[1], 1-cb[2], 1-cb[3], 0
  end
end

pdfetcs.clrspcs = setmetatable({ }, { __index = function(t,names)
  run_tex_code({
    [[\color_model_new:nnn]],
    format("{mplibcolorspace_%s}", names:gsub(",","_")),
    format("{DeviceN}{names={%s}}", names),
    [[\edef\mplib_@tempa{\pdf_object_ref_last:}]],
  }, ccexplat)
  local colorspace = get_macro'mplib_@tempa'
  t[names] = colorspace
  return colorspace
end })

local function do_preobj_SH(object,prescript)
  local shade_no
  local sh_type = prescript and prescript.sh_type
  if not sh_type then
    return
  else
    local domain  = prescript.sh_domain or "0 1"
    local centera = prescript.sh_center_a or "0 0"; centera = centera:explode()
    local centerb = prescript.sh_center_b or "0 0"; centerb = centerb:explode()
    local transform = prescript.sh_transform == "yes"
    local sx,sy,sr,dx,dy = 1,1,1,0,0
    if transform then
      local first = prescript.sh_first or "0 0"; first = first:explode()
      local setx = prescript.sh_set_x or "0 0";  setx = setx:explode()
      local sety = prescript.sh_set_y or "0 0";  sety = sety:explode()
      local x,y = tonumber(setx[1]) or 0, tonumber(sety[1]) or 0
      if x ~= 0 and y ~= 0 then
        local path = object.path
        local path1x = path[1].x_coord
        local path1y = path[1].y_coord
        local path2x = path[x].x_coord
        local path2y = path[y].y_coord
        local dxa = path2x - path1x
        local dya = path2y - path1y
        local dxb = setx[2] - first[1]
        local dyb = sety[2] - first[2]
```

```
      if dxa ~= 0 and dya ~= 0 and dxb ~= 0 and dyb ~= 0 then
        sx = dxa / dxb ; if sx < 0 then sx = - sx end
        sy = dya / dyb ; if sy < 0 then sy = - sy end
        sr = math.sqrt(sx^2 + sy^2)
        dx = path1x - sx*first[1]
        dy = path1y - sy*first[2]
      end
    end
  end
  local ca, cb, colorspace, steps, fractions
  ca = { prescript.sh_color_a_1 or prescript.sh_color_a or {0} }
  cb = { prescript.sh_color_b_1 or prescript.sh_color_b or {1} }
  steps = tonumber(prescript.sh_step) or 1
  if steps > 1 then
    fractions = { prescript.sh_fraction_1 or 0 }
    for i=2,steps do
      fractions[i] = prescript[format("sh_fraction_%i",i)] or (i/steps)
      ca[i] = prescript[format("sh_color_a_%i",i)] or {0}
      cb[i] = prescript[format("sh_color_b_%i",i)] or {1}
    end
  end
  if prescript.mplib_spotcolor then
    ca, cb = { }, { }
    local names, pos, objref = { }, -1, ""
    local script = object.prescript:explode"\13+"
    for i=#script,1,-1 do
      if script[i]:find"mplib_spotcolor" then
        local name, value
        objref, name = script[i]:match"=(.-):(.+)"
        value = script[i+1]:match"=(.+)"
        if not names[name] then
          pos = pos+1
          names[name] = pos
          names[#names+1] = name
        end
        local t = { }
        for j=1,names[name] do t[#t+1] = 0 end
        t[#t+1] = value
        tableinsert(#ca == #cb and ca or cb, t)
      end
    end
    for _,t in ipairs{ca,cb} do
      for _,tt in ipairs(t) do
        for i=1,#names-#tt do tt[#tt+1] = 0 end
      end
    end
    if #names == 1 then
      colorspace = objref
    else
      colorspace = pdfetcs.clrspcs[ tableconcat(names,",") ]
    end
  else
    local model = 0
    for _,t in ipairs{ca,cb} do
```

```
      for _,tt in ipairs(t) do
        model = model > #tt and model or #tt
      end
    end
    for _,t in ipairs{ca,cb} do
      for _,tt in ipairs(t) do
        if #tt < model then
          color_normalize(model == 4 and {1,1,1,1} or {1,1,1},tt)
        end
      end
    end
    colorspace = model == 4 and "/DeviceCMYK"
              or model == 3 and "/DeviceRGB"
              or model == 1 and "/DeviceGray"
              or err"unknown color model"
  end
  if sh_type == "linear" then
    local coordinates = format("%f %f %f %f",
      dx + sx*centera[1], dy + sy*centera[2],
      dx + sx*centerb[1], dy + sy*centerb[2])
    shade_no = sh_pdfpageresources(2,domain,colorspace,ca,cb,coordinates,steps,fractions)
  elseif sh_type == "circular" then
    local factor = prescript.sh_factor or 1
    local radiusa = factor * prescript.sh_radius_a
    local radiusb = factor * prescript.sh_radius_b
    local coordinates = format("%f %f %f %f %f %f",
      dx + sx*centera[1], dy + sy*centera[2], sr*radiusa,
      dx + sx*centerb[1], dy + sy*centerb[2], sr*radiusb)
    shade_no = sh_pdfpageresources(3,domain,colorspace,ca,cb,coordinates,steps,fractions)
  else
    err"unknown shading type"
  end
  pdf_literalcode("q /Pattern cs")
 end
 return shade_no
end
```

Patterns

```
patterns = { c_l_r_s_p_c_s_ = { } }
function luamplib.registerpattern ( boxid, name, opts )
 local box = texgetbox(boxid)
 if opts.xstep == 0 then opts.xstep = nil end
 if opts.ystep == 0 then opts.ystep = nil end
 if opts.colored == nil then opts.colored = true end
 local attr = {
   "/Type/Pattern",
   "/PatternType 1",
   format("/PaintType %i", opts.colored and 1 or 2),
   "/TilingType 2",
   format("/XStep %.3f", opts.xstep or box.width/factor),
   format("/YStep %.3f", opts.ystep or (box.height+box.depth)/factor),
   format("/Matrix [%s %s %s]", opts.matrix or "1 0 0 1", opts.xshift or 0, opts.yshift or 0),
 }
 if pdfmode then
```

```
    if opts.bbox then
      attr[#attr+1] = format("/BBox [%s]", opts.bbox)
    end
    local index = tex.saveboxresource(boxid,tableconcat(attr),opts.resources,true,opts.bbox and 4 or 1)
    patterns[name] = { id = index, colored = opts.colored }
  else
    local objname = "@mplibpattern"..name
    local metric = opts.bbox and format("bbox %s",opts.bbox) or
      format([[width \the\wd%i \space height \the\ht%i \space depth \the\dp%i]],boxid,boxid,boxid)
    texsprint {
      [[\ifvmode\nointerlineskip\fi]],
      format([[\hbox to0pt{\vbox to0pt{\hsize=\wd %i\vss\noindent]], boxid), -- force horiz mode?
      [[\special{pdf:bcontent}]],
      [[\special{pdf:bxobj ]], objname, format(" %s}", metric),
      format([[\box %i]], boxid),
      [[\special{pdf:exobj <<]], tableconcat(attr), ">>}",
      [[\special{pdf:econtent}]],
      [[\par}\hss}]],
    }
    patterns[#patterns+1] = objname
    patterns[name] = { id = #patterns, colored = opts.colored }
  end
end
local function pattern_colorspace (cs, ref)
  local on, new = update_pdfobjs(format("[/Pattern %s]", ref or format("/%s",cs)))
  if new then
    local key = format("MPlibCS%i",on)
    local val = pdfmode and format("%i 0 R",on) or format("@mplibpdfobj%i",on)
    if pdfmanagement then
      texsprint(ccexplat,format("\\pdfmanagement_add:nnn{Page/Resources/ColorSpace}{%s}{%s}",key,val))
    else
      local res = format("/%s %s", key, val)
      if is_defined"pgf@sys@addpdfresource@colorspaces@plain" then
        texsprint(catat11, format("\\pgf@sys@addpdfresource@colorspaces@plain{%s}", res))
      elseif pdfmode then
        if not pdfetcs.ColorSpace_res then
          pdfetcs.initialize_resources"ColorSpace"
        end
        pdfetcs.fallback_update_resources("ColorSpace", res)
      else
        texsprint(format("\\special{pdf:put @MPlibCS<<%s>>}", res))
        texsprint"\\special{pdf:put @resources<</ColorSpace @MPlibCS>>}"
      end
    end
    patterns.c_l_r_s_p_c_s_[cs] = on
  end
  return on
end
local function do_preobj_PAT(object, prescript)
  local name = prescript and prescript.mplibpattern
  if not name then return end
  local patt = patterns[name]
  local index = patt and patt.id or err("cannot get pattern object '%s'", name)
  local key = format("MPlibPt%s",index)
```

```
  if patt.colored then
    pdf_literalcode("/Pattern cs /%s scn", key)
  else
    local color = prescript.mpliboverridecolor
    if not color then
      local t = object.color
      color = t and #t>0 and luamplib.colorconverter(t)
    end
    if not color then return end
    local csobj, cs, ref
    if color:find" cs " or color:find"@pdf.obj" then
      local t = color:explode()
      if pdfmode then
        cs = t[1]:sub(2,-1)
        ref = format("%s 0 R", ltx.pdf.object_id(cs))
        color = t[3]
      else
        cs, ref = t[2], t[2]
        color = t[3]:match"%[(.+)%]"
      end
    else
      local t = colorsplit(color)
      cs = #t == 4 and "DeviceCMYK" or #t == 3 and "DeviceRGB" or "DeviceGray"
      color = tableconcat(t," ")
    end
    csobj = patterns.c_l_r_s_p_c_s_[cs] or pattern_colorspace(cs, ref)
    pdf_literalcode("/MPlibCS%i cs %s /%s scn", csobj, color, key)
  end
  if patt.done then return end
  local val = pdfmode and format("%s 0 R",index) or patterns[index]
  if pdfmanagement then
    texsprint(ccexplat, format("\\pdfmanagement_add:nnn{Page/Resources/Pattern}{%s}{%s}",key,val))
  else
    local res = format("/%s %s", key, val)
    if is_defined"pgf@sys@addpdfresource@patterns@plain" then
      texsprint(catat11, format("\\pgf@sys@addpdfresource@patterns@plain{%s}", res))
    elseif pdfmode then
      if not pdfetcs.Pattern_res then
        pdfetcs.initialize_resources"Pattern"
      end
      pdfetcs.fallback_update_resources("Pattern", res)
    else
      texsprint(format("\\special{pdf:put @MPlibPt<<%s>>}", res))
      texsprint"\\special{pdf:put @resources<</Pattern @MPlibPt>>}"
    end
  end
  patt.done = true
end

```

Finally, flush figures by inserting PDF literals.

```
function luamplib.flush (result,flusher)
  if result then
    local figures = result.fig
    if figures then
```

```
    for f=1, #figures do
      info("flushing figure %s",f)
      local figure = figures[f]
      local objects = getobjects(result,figure,f)
      local fignum = tonumber(figure:filename():match("([%d]+)$") or figure:charcode() or 0)
      local miterlimit, linecap, linejoin, dashed = -1, -1, -1, false
      local bbox = figure:boundingbox()
      local llx, lly, urx, ury = bbox[1], bbox[2], bbox[3], bbox[4] -- faster than unpack
      if urx < llx then
```

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

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

```
      else
```

For legacy behavior, insert 'pre-fig' TEX code here.

```
        if tex_code_pre_mplib[f] then
          put2output(tex_code_pre_mplib[f])
        end
        pdf_startfigure(fignum,llx,lly,urx,ury)
        start_pdf_code()
        if objects then
          local savedpath = nil
          local savedhtap = nil
          for o=1,#objects do
            local object       = objects[o]
            local objecttype   = object.type
```

The following 6 lines are part of `btex...etex` patch. Again, colors are processed at this stage.

```
            local prescript    = object.prescript
            prescript = prescript and script2table(prescript) -- prescript is now a table
            local cr_over = do_preobj_CR(object,prescript) -- color
            local tr_opaq = do_preobj_TR(object,prescript) -- opacity
            if prescript and prescript.mplibtexboxid then
              put_tex_boxes(object,prescript)
            elseif objecttype == "start_bounds" or objecttype == "stop_bounds" then --skip
            elseif objecttype == "start_clip" then
              local evenodd = not object.istext and object.postscript == "evenodd"
              start_pdf_code()
              flushnormalpath(object.path,false)
              pdf_literalcode(evenodd and "W* n" or "W n")
            elseif objecttype == "stop_clip" then
              stop_pdf_code()
              miterlimit, linecap, linejoin, dashed = -1, -1, -1, false
            elseif objecttype == "special" then
```

Collect TEX codes that will be executed after flushing. Legacy behavior.

```
              if prescript and prescript.postmplibverbtex then
                figcontents.post[#figcontents.post+1] = prescript.postmplibverbtex
              end
```

```
2177            elseif objecttype == "text" then
2178              local ot = object.transform -- 3,4,5,6,1,2
2179              start_pdf_code()
2180              pdf_literalcode("%f %f %f %f %f %f cm",ot[3],ot[4],ot[5],ot[6],ot[1],ot[2])
2181              pdf_textfigure(object.font,object.dsize,object.text,object.width,object.height,object.depth)
2182              stop_pdf_code()
2183            else
2184              local evenodd, collect, both = false, false, false
2185              local postscript = object.postscript
2186              if not object.istext then
2187                if postscript == "evenodd" then
2188                  evenodd = true
2189                elseif postscript == "collect" then
2190                  collect = true
2191                elseif postscript == "both" then
2192                  both = true
2193                elseif postscript == "eoboth" then
2194                  evenodd = true
2195                  both    = true
2196                end
2197              end
2198              if collect then
2199                if not savedpath then
2200                  savedpath = { object.path or false }
2201                  savedhtap = { object.htap or false }
2202                else
2203                  savedpath[#savedpath+1] = object.path or false
2204                  savedhtap[#savedhtap+1] = object.htap or false
2205                end
2206              else
```

Removed from ConTeXt general: color stuff. Added instead : shading stuff

```
2207                local shade_no = do_preobj_SH(object,prescript) -- shading
2208                local pattern_ = do_preobj_PAT(object,prescript) -- pattern
2209                local ml = object.miterlimit
2210                if ml and ml ~= miterlimit then
2211                  miterlimit = ml
2212                  pdf_literalcode("%f M",ml)
2213                end
2214                local lj = object.linejoin
2215                if lj and lj ~= linejoin then
2216                  linejoin = lj
2217                  pdf_literalcode("%i j",lj)
2218                end
2219                local lc = object.linecap
2220                if lc and lc ~= linecap then
2221                  linecap = lc
2222                  pdf_literalcode("%i J",lc)
2223                end
2224                local dl = object.dash
2225                if dl then
2226                  local d = format("[%s] %f d",tableconcat(dl.dashes or {}," "),dl.offset)
2227                  if d ~= dashed then
2228                    dashed = d
2229                    pdf_literalcode(dashed)
```

```
    end
  elseif dashed then
    pdf_literalcode("[] 0 d")
    dashed = false
  end
  local path = object.path
  local transformed, penwidth = false, 1
  local open = path and path[1].left_type and path[#path].right_type
  local pen = object.pen
  if pen then
    if pen.type == 'elliptical' then
      transformed, penwidth = pen_characteristics(object) -- boolean, value
      pdf_literalcode("%f w",penwidth)
      if objecttype == 'fill' then
        objecttype = 'both'
      end
    else -- calculated by mplib itself
      objecttype = 'fill'
    end
  end
  if transformed then
    start_pdf_code()
  end
  if path then
    if savedpath then
      for i=1,#savedpath do
        local path = savedpath[i]
        if transformed then
          flushconcatpath(path,open)
        else
          flushnormalpath(path,open)
        end
      end
      savedpath = nil
    end
    if transformed then
      flushconcatpath(path,open)
    else
      flushnormalpath(path,open)
    end
```

Shading seems to conflict with these ops

```
    if not shade_no then -- conflict with shading
      if objecttype == "fill" then
        pdf_literalcode(evenodd and "h f*" or "h f")
      elseif objecttype == "outline" then
        if both then
          pdf_literalcode(evenodd and "h B*" or "h B")
        else
          pdf_literalcode(open and "S" or "h S")
        end
      elseif objecttype == "both" then
        pdf_literalcode(evenodd and "h B*" or "h B")
      end
    end
```

```
            end
            if transformed then
              stop_pdf_code()
            end
            local path = object.htap
            if path then
              if transformed then
                start_pdf_code()
              end
              if savedhtap then
                for i=1,#savedhtap do
                  local path = savedhtap[i]
                  if transformed then
                    flushconcatpath(path,open)
                  else
                    flushnormalpath(path,open)
                  end
                end
                savedhtap = nil
                evenodd   = true
              end
              if transformed then
                flushconcatpath(path,open)
              else
                flushnormalpath(path,open)
              end
              if objecttype == "fill" then
                pdf_literalcode(evenodd and "h f*" or "h f")
              elseif objecttype == "outline" then
                pdf_literalcode(open and "S" or "h S")
              elseif objecttype == "both" then
                pdf_literalcode(evenodd and "h B*" or "h B")
              end
              if transformed then
                stop_pdf_code()
              end
            end
```

Added to ConTeXt general: post-object color and shading stuff.

```
            if shade_no then -- shading
              pdf_literalcode("W n /MPlibSh%s sh Q",shade_no)
            end
          end
        end
        if tr_opaq then -- opacity
          stop_pdf_code()
        end
        if cr_over then -- color
          put2output"\\special{pdf:ec}"
        end
      end
    end
    stop_pdf_code()
    pdf_stopfigure()
```

output collected materials to PDF, plus legacy verbatimtex code.

```
          for _,v in ipairs(figcontents) do
            if type(v) == "table" then
              texsprint"\\mplibtoPDF{"; texsprint(v[1], v[2]); texsprint"}"
            else
              texsprint(v)
            end
          end
          if #figcontents.post > 0 then texsprint(figcontents.post) end
          figcontents = { post = { } }
        end
      end
    end
  end
end

function luamplib.colorconverter (cr)
  local n = #cr
  if n == 4 then
    local c, m, y, k = cr[1], cr[2], cr[3], cr[4]
    return format("%.3f %.3f %.3f %.3f k %.3f %.3f %.3f %.3f K",c,m,y,k,c,m,y,k), "0 g 0 G"
  elseif n == 3 then
    local r, g, b = cr[1], cr[2], cr[3]
    return format("%.3f %.3f %.3f rg %.3f %.3f %.3f RG",r,g,b,r,g,b), "0 g 0 G"
  else
    local s = cr[1]
    return format("%.3f g %.3f G",s,s), "0 g 0 G"
  end
end
```

2.2 TEX package

First we need to load some packages.

```
\bgroup\expandafter\expandafter\expandafter\egroup
\expandafter\ifx\csname selectfont\endcsname\relax
  \input ltluatex
\else
  \NeedsTeXFormat{LaTeX2e}
  \ProvidesPackage{luamplib}
    [2024/06/10 v2.32.0 mplib package for LuaTeX]
  \ifx\newluafunction\@undefined
  \input ltluatex
  \fi
\fi
```

Loading of lua code.

```
\directlua{require("luamplib")}
```

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

```
\ifx\pdfoutput\undefined
  \let\pdfoutput\outputmode
\fi
\ifx\pdfliteral\undefined
  \protected\def\pdfliteral{\pdfextension literal}
```

```
\fi
```

Set the format for metapost.

```
\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.

```
\ifnum\pdfoutput>0
  \let\mplibtoPDF\pdfliteral
\else
  \def\mplibtoPDF#1{\special{pdf:literal direct #1}}
  \ifcsname PackageInfo\endcsname
    \PackageInfo{luamplib}{only dvipdfmx is supported currently}
  \else
    \immediate\write-1{luamplib Info: only dvipdfmx is supported currently}
  \fi
\fi
```

To make `mplibcode` typeset always in horizontal mode.

```
\def\mplibforcehmode{\let\prependtomplibbox\leavevmode}
\def\mplibnoforcehmode{\let\prependtomplibbox\relax}
\mplibnoforcehmode
```

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

```
\def\mplibsetupcatcodes{%
  %catcode`\{=12 %catcode`\}=12
  \catcode`\#=12 \catcode`\^=12 \catcode`\~=12 \catcode`\_=12
  \catcode`\&=12 \catcode`\$=12 \catcode`\%=12 \catcode`\^^M=12
}
```

Make btex...etex box zero-metric.

```
\def\mplibputtextbox#1{\vbox to 0pt{\vss\hbox to 0pt{\raise\dp#1\copy#1\hss}}}
```

Patterns

```
{\def\:{\global\let\mplibsptoken= } \: }
\protected\def\mppattern#1{%
  \begingroup
  \def\mplibpatternname{#1}%
  \mplibpatterngetnexttok
}
\def\mplibpatterngetnexttok{\futurelet\nexttok\mplibpatternbranch}
\def\mplibpatternskipspace{\afterassignment\mplibpatterngetnexttok\let\nexttok= }
\def\mplibpatternbranch{%
  \ifx [\nexttok
    \expandafter\mplibpatternopts
  \else
    \ifx\mplibsptoken\nexttok
      \expandafter\expandafter\expandafter\mplibpatternskipspace
    \else
      \let\mplibpatternoptions\empty
      \expandafter\expandafter\expandafter\mplibpatternmain
    \fi
  \fi
}
\def\mplibpatternopts[#1]{%
  \def\mplibpatternoptions{#1}%
```

```
  \mplibpatternmain
}
\def\mplibpatternmain{%
  \setbox\mplibscratchbox\hbox\bgroup\ignorespaces
}
\protected\def\endmppattern{%
  \egroup
  \directlua{ luamplib.registerpattern(
    \the\mplibscratchbox, '\mplibpatternname', {\mplibpatternoptions}
  )}%
  \endgroup
}
```

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

```
\def\mpfiginstancename{@mpfig}
\protected\def\mpfig{%
  \begingroup
  \futurelet\nexttok\mplibmpfigbranch
}
\def\mplibmpfigbranch{%
  \ifx *\nexttok
    \expandafter\mplibprempfig
  \else
    \expandafter\mplibmainmpfig
  \fi
}
\def\mplibmainmpfig{%
  \begingroup
  \mplibsetupcatcodes
  \mplibdomainmpfig
}
\long\def\mplibdomainmpfig#1\endmpfig{%
  \endgroup
  \directlua{
    local legacy = luamplib.legacy_verbatimtex
    local everympfig = luamplib.everymplib["\mpfiginstancename"] or ""
    local everyendmpfig = luamplib.everyendmplib["\mpfiginstancename"] or ""
    luamplib.legacy_verbatimtex = false
    luamplib.everymplib["\mpfiginstancename"] = ""
    luamplib.everyendmplib["\mpfiginstancename"] = ""
    luamplib.process_mplibcode(
    "beginfig(0) "..everympfig.." "..[===[\unexpanded{#1}]===].." "..everyendmpfig.." endfig;",
    "\mpfiginstancename")
    luamplib.legacy_verbatimtex = legacy
    luamplib.everymplib["\mpfiginstancename"] = everympfig
    luamplib.everyendmplib["\mpfiginstancename"] = everyendmpfig
  }%
  \endgroup
}
\def\mplibprempfig#1{%
  \begingroup
  \mplibsetupcatcodes
  \mplibdoprempfig
}
\long\def\mplibdoprempfig#1\endmpfig{%
```

```
  \endgroup
  \directlua{
    local legacy = luamplib.legacy_verbatimtex
    local everympfig = luamplib.everymplib["\mpfiginstancename"]
    local everyendmpfig = luamplib.everyendmplib["\mpfiginstancename"]
    luamplib.legacy_verbatimtex = false
    luamplib.everymplib["\mpfiginstancename"] = ""
    luamplib.everyendmplib["\mpfiginstancename"] = ""
    luamplib.process_mplibcode([===[\unexpanded{#1}]===],"\mpfiginstancename")
    luamplib.legacy_verbatimtex = legacy
    luamplib.everymplib["\mpfiginstancename"] = everympfig
    luamplib.everyendmplib["\mpfiginstancename"] = everyendmpfig
  }%
  \endgroup
}
\protected\def\endmpfig{endmpfig}
```

The Plain-specific stuff.

```
\unless\ifcsname ver@luamplib.sty\endcsname
  \def\mplibcodegetinstancename[#1]{\gdef\currentmpinstancename{#1}\mplibcodeindeed}
  \protected\def\mplibcode{%
    \begingroup
    \futurelet\nexttok\mplibcodebranch
  }
  \def\mplibcodebranch{%
    \ifx [\nexttok
      \expandafter\mplibcodegetinstancename
    \else
      \global\let\currentmpinstancename\empty
      \expandafter\mplibcodeindeed
    \fi
  }
  \def\mplibcodeindeed{%
    \begingroup
    \mplibsetupcatcodes
    \mplibdocode
  }
  \long\def\mplibdocode#1\endmplibcode{%
    \endgroup
    \directlua{luamplib.process_mplibcode([===[\unexpanded{#1}]===],"\currentmpinstancename")}%
    \endgroup
  }
  \protected\def\endmplibcode{endmplibcode}
\else
```

The LaTeX-specific part: a new environment.

```
  \newenvironment{mplibcode}[1][]{%
    \global\def\currentmpinstancename{#1}%
    \mplibtmptoks{}\ltxdomplibcode
  }{}
  \def\ltxdomplibcode{%
    \begingroup
    \mplibsetupcatcodes
    \ltxdomplibcodeindeed
  }
```

```
  \def\mplib@mplibcode{mplibcode}
  \long\def\ltxdomplibcodeindeed#1\end#2{%
    \endgroup
    \mplibtmptoks\expandafter{\the\mplibtmptoks#1}%
    \def\mplibtemp@a{#2}%
    \ifx\mplib@mplibcode\mplibtemp@a
      \directlua{luamplib.process_mplibcode([===[\the\mplibtmptoks]===],"\currentmpinstancename")}%
      \end{mplibcode}%
    \else
      \mplibtmptoks\expandafter{\the\mplibtmptoks\end{#2}}%
      \expandafter\ltxdomplibcode
    \fi
  }
\fi
```

User settings.

```
\def\mplibshowlog#1{\directlua{
    local s = string.lower("#1")
    if s == "enable" or s == "true" or s == "yes" then
      luamplib.showlog = true
    else
      luamplib.showlog = false
    end
}}
\def\mpliblegacybehavior#1{\directlua{
    local s = string.lower("#1")
    if s == "enable" or s == "true" or s == "yes" then
      luamplib.legacy_verbatimtex = true
    else
      luamplib.legacy_verbatimtex = false
    end
}}
\def\mplibverbatim#1{\directlua{
    local s = string.lower("#1")
    if s == "enable" or s == "true" or s == "yes" then
      luamplib.verbatiminput = true
    else
      luamplib.verbatiminput = false
    end
}}
\newtoks\mplibtmptoks
```

\everymplib & \everyendmplib: macros resetting luamplib.every(end)mplib tables

```
\ifcsname ver@luamplib.sty\endcsname
  \protected\def\everymplib{%
    \begingroup
    \mplibsetupcatcodes
    \mplibdoeverymplib
  }
  \protected\def\everyendmplib{%
    \begingroup
    \mplibsetupcatcodes
    \mplibdoeveryendmplib
  }
  \newcommand\mplibdoeverymplib[2][]{%
```

```
    \endgroup
    \directlua{
      luamplib.everymplib["#1"] = [===[\unexpanded{#2}]===]
    }%
  }
  \newcommand\mplibdoeveryendmplib[2][]{%
    \endgroup
    \directlua{
      luamplib.everyendmplib["#1"] = [===[\unexpanded{#2}]===]
    }%
  }
\else
  \def\mplibgetinstancename[#1]{\def\currentmpinstancename{#1}}
  \protected\def\everymplib#1#{%
    \ifx\empty#1\empty \mplibgetinstancename[]\else \mplibgetinstancename#1\fi
    \begingroup
    \mplibsetupcatcodes
    \mplibdoeverymplib
  }
  \long\def\mplibdoeverymplib#1{%
    \endgroup
    \directlua{
      luamplib.everymplib["\currentmpinstancename"] = [===[\unexpanded{#1}]===]
    }%
  }
  \protected\def\everyendmplib#1#{%
    \ifx\empty#1\empty \mplibgetinstancename[]\else \mplibgetinstancename#1\fi
    \begingroup
    \mplibsetupcatcodes
    \mplibdoeveryendmplib
  }
  \long\def\mplibdoeveryendmplib#1{%
    \endgroup
    \directlua{
      luamplib.everyendmplib["\currentmpinstancename"] = [===[\unexpanded{#1}]===]
    }%
  }
\fi
```

Allow TEX dimen/color macros. Now `runscript` does the job, so the following lines are not needed for most cases. But the macros will be expanded when they are used in another macro.

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

MPLib's number system. Now `binary` has gone away.

```
\def\mplibnumbersystem#1{\directlua{
  local t = "#1"
  if t == "binary" then t = "decimal" end
  luamplib.numbersystem = t
}}
```

Settings for `.mp` cache files.

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

```
\def\mplibdomakenocache#1,{%
  \ifx\empty#1\empty
    \expandafter\mplibdomakenocache
  \else
    \ifx*#1\else
      \directlua{luamplib.noneedtoreplace["#1.mp"]=true}%
      \expandafter\expandafter\expandafter\mplibdomakenocache
    \fi
  \fi
}
\def\mplibcancelnocache#1{\mplibdocancelnocache #1,*,}
\def\mplibdocancelnocache#1,{%
  \ifx\empty#1\empty
    \expandafter\mplibdocancelnocache
  \else
    \ifx*#1\else
      \directlua{luamplib.noneedtoreplace["#1.mp"]=false}%
      \expandafter\expandafter\expandafter\mplibdocancelnocache
    \fi
  \fi
}
\def\mplibcachedir#1{\directlua{luamplib.getcachedir("\unexpanded{#1}")}}
```

More user settings.

```
\def\mplibtextextlabel#1{\directlua{
    local s = string.lower("#1")
    if s == "enable" or s == "true" or s == "yes" then
      luamplib.textextlabel = true
    else
      luamplib.textextlabel = false
    end
}}
\def\mplibcodeinherit#1{\directlua{
    local s = string.lower("#1")
    if s == "enable" or s == "true" or s == "yes" then
      luamplib.codeinherit = true
    else
      luamplib.codeinherit = false
    end
}}
\def\mplibglobaltextext#1{\directlua{
    local s = string.lower("#1")
    if s == "enable" or s == "true" or s == "yes" then
      luamplib.globaltextext = true
    else
      luamplib.globaltextext = false
    end
}}
```

The followings are from ConTeXt general, mostly. We use a dedicated scratchbox.

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

We encapsulate the litterals.

```
\def\mplibstarttoPDF#1#2#3#4{%
  \prependtomplibbox
```

```
  \hbox dir TLT\bgroup
  \xdef\MPllx{#1}\xdef\MPlly{#2}%
  \xdef\MPurx{#3}\xdef\MPury{#4}%
  \xdef\MPwidth{\the\dimexpr#3bp-#1bp\relax}%
  \xdef\MPheight{\the\dimexpr#4bp-#2bp\relax}%
  \parskip0pt%
  \leftskip0pt%
  \parindent0pt%
  \everypar{}%
  \setbox\mplibscratchbox\vbox\bgroup
  \noindent
}
\def\mplibstoptoPDF{%
  \par
  \egroup %
  \setbox\mplibscratchbox\hbox %
    {\hskip-\MPllx bp%
     \raise-\MPlly bp%
     \box\mplibscratchbox}%
  \setbox\mplibscratchbox\vbox to \MPheight
    {\vfill
     \hsize\MPwidth
     \wd\mplibscratchbox0pt%
     \ht\mplibscratchbox0pt%
     \dp\mplibscratchbox0pt%
     \box\mplibscratchbox}%
  \wd\mplibscratchbox\MPwidth
  \ht\mplibscratchbox\MPheight
  \box\mplibscratchbox
  \egroup
}
```

Text items have a special handler.

```
\def\mplibtextext#1#2#3#4#5{%
  \begingroup
  \setbox\mplibscratchbox\hbox
    {\font\temp=#1 at #2bp%
     \temp
     #3}%
  \setbox\mplibscratchbox\hbox
    {\hskip#4 bp%
     \raise#5 bp%
     \box\mplibscratchbox}%
  \wd\mplibscratchbox0pt%
  \ht\mplibscratchbox0pt%
  \dp\mplibscratchbox0pt%
  \box\mplibscratchbox
  \endgroup
}
```

Input `luamplib.cfg` when it exists.

```
\openin0=luamplib.cfg
\ifeof0 \else
  \closein0
  \input luamplib.cfg
```

```
2725 \fi
```

That's all folks!

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