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 luatexbase for errors, warnings and declaration
- 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.)

\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
```

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}
```

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.

\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--(\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.

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.

`\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 environment v2.22 has added the support for several named MetaPost instances in LATEX `mplibcode` environment. 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).
- `btex ... etex` labels still exist separately and 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 To inherit btex ... etex labels as well as metapost variables, it is necessary to declare \mplibglobaltextext{enable} in advance. On this case, be careful that normal TEX boxes can conflict with btex ... etex boxes, though this would occur very rarely. Notwithstanding the danger, it is a 'must' option to activate \mplibglobaltextext if you want to use graph.mp with \mplibcodeinherit functionality.

```
\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
```

\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)

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 or \mplibforcehmode 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       = "2.26.4",
5   date          = "2024/03/10",
6   description   = "Lua package to typeset Metapost with LuaTeX's MPLib.",
7 }
8
9 local format, abs = string.format, math.abs
10
11 local err  = function(...)
```

```
  return luatexbase.module_error  ("luamplib", select("#",...) > 1 and format(...) or ...)
end
local warn = function(...)
  return luatexbase.module_warning("luamplib", select("#",...) > 1 and format(...) or ...)
end
local info = function(...)
  return luatexbase.module_info   ("luamplib", select("#",...) > 1 and format(...) or ...)
end

```

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

```
luamplib          = luamplib or { }
local luamplib    = luamplib

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 texsprint     = tex.sprint
local textprint     = tex.tprint

local texget      = tex.get
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 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
```

```
55
56 local is_writable = file.is_writable or function(name)
57   if lfsisdir(name) then
58     name = name .. "/_luam_plib_temp_file_"
59     local fh = ioopen(name,"w")
60     if fh then
61       fh:close(); os.remove(name)
62       return true
63     end
64   end
65 end
66 local mk_full_path = lfs.mkdirp or lfs.mkdirs or function(path)
67   local full = ""
68   for sub in path:gmatch("(/*[^\\/]+)") do
69     full = full .. sub
70     lfsmkdir(full)
71   end
72 end
73
```

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.

```
74 local luamplibtime = kpse.find_file("luamplib.lua")
75 luamplibtime = luamplibtime and lfsattributes(luamplibtime,"modification")
76
77 local currenttime = os.time()
78
79 local outputdir
80 if lfstouch then
81   for i,v in ipairs{'TEXMFVAR','TEXMF_OUTPUT_DIRECTORY','.','TEXMFOUTPUT'} do
82     local var = i == 3 and v or kpse.var_value(v)
83     if var and var ~= "" then
84       for _,vv in next, var:explode(os.type == "unix" and ":" or ";") do
85         local dir = format("%s/%s",vv,"luamplib_cache")
86         if not lfsisdir(dir) then
87           mk_full_path(dir)
88         end
89         if is_writable(dir) then
90           outputdir = dir
91           break
92         end
93       end
94       if outputdir then break end
95     end
96   end
97 end
98 outputdir = outputdir or '.'
99
100 function luamplib.getcachedir(dir)
101   dir = dir:gsub("##","#")
102   dir = dir:gsub("^~",
103     os.type == "windows" and os.getenv("UserProfile") or os.getenv("HOME"))
104   if lfstouch and dir then
```

```
    if lfsisdir(dir) then
      if is_writable(dir) then
        luamplib.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 cachedir = luamplib.cachedir or outputdir
  local newfile = name:gsub("%W","_")
  newfile = cachedir .."/luamplib_input_"..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",
}

local function finder(name, mode, ftype)
  if mode == "w" then
    if name and name ~= "mpout.log" then
      kpse.record_output_file(name) -- recorder
    end
    return name
  else
    ftype = special_ftype[ftype] or ftype
    local file = mpkpse:find_file(name,ftype)
    if file then
      if lfstouch and ftype == "mp" and not noneedtoreplace[name] then
        file = replaceinputmpfile(name,file)
      end
    else
      file = mpkpse:find_file(name, name:match("%a+$"))
    end
    if file then
      kpse.record_input_file(file) -- recorder
    end
    return file
  end
end
luamplib.finder = finder

```

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.)

```
if tonumber(mplib.version()) <= 1.50 then
  err("luamplib no longer supports mplib v1.50 or lower. "..
  "Please upgrade to the latest version of LuaTeX")
end

local preamble = [[
  boolean mplib ; mplib := true ;
  let dump = endinput ;
  let normalfontsize = fontsize;
  input %s ;
]]

local logatload
local function reporterror (result, indeed)
```

```
  if not result then
    err("no result object returned")
  else
    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
      warn(log)
      if result.status > 1 then
        err(e or "see above messages")
      end
    elseif indeed then
      local log = logatload..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 a warning, even if output has no figure.

```
      if log:find"\n>>" then
        warn(log)
      elseif log:find"%g" then
        if luamplib.showlog then
          info(log)
        elseif not result.fig then
          info(log)
        end
      end
      logatload = ""
    else
      logatload = log
    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 = preamble .. luamplib.mplibcodepreamble
```

```
  if luamplib.legacy_verbatimtex then
    preamble = preamble .. luamplib.legacyverbatimtexpreamble
  end
  if luamplib.textextlabel then
    preamble = preamble .. luamplib.textextlabelpreamble
  end
  local result
  if not mpx then
    result = { status = 99, error = "out of memory"}
  else
    result = mpx:execute(format(preamble, replacesuffix(name,"mp")))
  end
  reporterror(result)
  return mpx, result
end

```

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

```
local currentformat = "plain"

local function setformat (name)
  currentformat = name
end
luamplib.setformat = setformat

```

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

```
local function process_indeed (mpx, data)
  local converted, result = false, {}
  if mpx and data then
    result = mpx:execute(data)
    local log = reporterror(result, true)
    if log then
      if result.fig then
        converted = luamplib.convert(result)
      else
        warn("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

```

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

```
luamplib.codeinherit = false
local mplibinstances = {}

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 defaultinstancename = currentformat .. (luamplib.numbersystem or "scaled")
    .. tostring(luamplib.textextlabel) .. tostring(luamplib.legacy_verbatimtex)
  local currfmt = instancename or defaultinstancename
  if #currfmt == 0 then
    currfmt = defaultinstancename
  end
  local mpx = mplibinstances[currfmt]
  local standalone = false
  if currfmt == defaultinstancename then
    standalone = not luamplib.codeinherit
  end
  if mpx and standalone then
    mpx:finish()
  end
  if standalone or not mpx then
    mpx = luamplibload(currentformat)
    mplibinstances[currfmt] = mpx
  end
  return process_indeed(mpx, data)
end
```

`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)
  cat = cat or catlatex
  texruntoks(function() texsprint(cat, str) end)
end
```

Indefinite number of boxes are needed for `btex ... etex`. So starts at somewhat huge number of box registry. Of course, this may conflict with other packages using many many boxes. (When `codeinherit` feature is enabled, boxes must be globally defined.) But I don't know any reliable way to escape this danger.

```
local tex_box_id = 2047
```

For conversion of `sp` to `bp`.

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

```
371
372 local textext_fmt = [[image(addto currentpicture doublepath unitsquare ]]..
373   [[xscaled %f yscaled %f shifted (0,-%f) ]]..
374   [[withprescript "mplibtexboxid=%i:%f:%f")]]
375
376 local function process_tex_text (str)
377   if str then
378     tex_box_id = tex_box_id + 1
379     local global = luamplib.globaltextext and "\\global" or ""
380     run_tex_code(format("%s\\setbox%i\\hbox{%s}", global, tex_box_id, str))
381     local box = texgetbox(tex_box_id)
382     local wd  = box.width  / factor
383     local ht  = box.height / factor
384     local dp  = box.depth  / factor
385     return textext_fmt:format(wd, ht+dp, dp, tex_box_id, wd, ht+dp)
386   end
387   return ""
388 end
389
```

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.

```
390 local mplibcolorfmt = {
391   xcolor = [[\begingroup\let\XC@mcolor\relax]]..
392   [[\def\set@color{\global\mplibtmptoks\expandafter{\current@color}}]]..
393   [[\color%s\endgroup]],
394   l3color = [[\begingroup]]..
395   [[\def\__color_select:N#1{\expandafter\__color_select:nn#1}]]..
396   [[\def\__color_backend_select:nn#1#2{\global\mplibtmptoks{#1 #2}}]]..
397   [[\def\__kernel_backend_literal:e#1{\global\mplibtmptoks\expandafter{\expanded{#1}}}]]..
398   [[\color_select:n%s\endgroup]],
399   l3xcolor = [[\begingroup\color_if_exist:nTF%s{]]..
400   [[\def\__color_select:N#1{\expandafter\__color_select:nn#1}]]..
401   [[\def\__color_backend_select:nn#1#2{\global\mplibtmptoks{#1 #2}}]]..
402   [[\def\__kernel_backend_literal:e#1{\global\mplibtmptoks\expandafter{\expanded{#1}}}]]..
403   [[\color_select:n%s}{\let\XC@mcolor\relax]]..
404   [[\def\set@color{\global\mplibtmptoks\expandafter{\current@color}}]]..
405   [[\color%s}\endgroup]],
406 }
407
408 local colfmt = is_defined'color_select:n' and "l3color" or "xcolor"
409 if colfmt == "l3color" then
410   run_tex_code{
411     "\\newcatcodetable\\luamplibcctabexplat",
412     "\\begingroup",
413     "\\catcode`@=11 ",
414     "\\catcode`_=11 ",
415     "\\catcode`:=11 ",
416     "\\savecatcodetable\\luamplibcctabexplat",
417     "\\endgroup",
418   }
419 end
420
```

```
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"ver@xcolor.sty" or is_defined"ver@color.sty") 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 = token.get_macro(format("l__color_named_%s_prop",v))
            if not pp or pp == "" then
              myfmt = mplibcolorfmt.xcolor
              break
            end
          end
        end
      end
    end
    run_tex_code(myfmt:format(str,str,str), ccexplat or catat11)
    local t = texgettoks"mplibtmptoks"
    return format('1 withprescript "MPlibOverrideColor=%s"', t)
  end
  return ""
end

```

`\mpdim` is expanded before MPLib process, so code below will not be used for `mplibcode` data. But who knows anyone would want it in `.mp` input file. If then, you can say `mplibdimen(".5\textwidth")` for example.

```
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`. 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 ig-

nored, 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 legacy_mplibcode_reset ()
  tex_code_pre_mplib = {}
  luamplib.figid = 1
end

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
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
    f()
    buffer = tableconcat(buffer)
    if buffer and buffer ~= "" then
      return buffer
    end
    buffer = {}
    mpprint(buffer, f())
    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
```

Our MetaPost preambles

```
local mplibcodepreamble = [[
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;
  def graphictext primary filename =
    if (readfrom filename = EOF):
      errmessage "Please prepare '"&filename&"' in advance with"&
      " 'pstoedit -ssp -dt -f mpost yourfile.ps "&filename&"'";
```

```
    fi
    closefrom filename;
    def data_mpy_file = filename enddef;
    mfun_do_graphic_text (filename)
  enddef;
else:
  vardef textext@# (text t) = rawtextext (t) enddef;
fi
def externalfigure primary filename =
  draw rawtextext("\includegraphics{"& filename &"}")
enddef;
def TEX = textext enddef;
]]
luamplib.mplibcodepreamble = mplibcodepreamble

local legacyverbatimtexpreamble = [[
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& ");";
]]
luamplib.legacyverbatimtexpreamble = legacyverbatimtexpreamble

local textextlabelpreamble = [[
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;
]]
luamplib.textextlabelpreamble = textextlabelpreamble
```

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    = { [""] = "" }
luamplib.everyendmplib = { [""] = "" }

local function process_mplibcode (data, instancename)
```

This is needed for legacy behavior regarding verbatimtex

```
  legacy_mplibcode_reset()

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

```

This three lines are needed for mplibverbatim mode.

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

  data = data:gsub(btex_etex, function(str)
    return format("btex %s etex ", -- space
      luamplib.verbatiminput and str or protect_expansion(str))
  end)
  data = data:gsub(verbatimtex_etex, function(str)
    return format("verbatimtex %s etex;", -- semicolon
      luamplib.verbatiminput and str or protect_expansion(str))
  end)

```

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.

```
  if not luamplib.verbatiminput then
    data = data:gsub("\".-\"", protect_expansion)

    data = data:gsub("\\%%", "\0PerCent\0")
    data = data:gsub("%%.-\n","")
    data = data:gsub("%zPerCent%z", "\\%%")

    run_tex_code(format("\\mplibtmptoks\\expandafter{\\expanded{%s}}",data))
```

```
    data = texgettoks"mplibtmptoks"
```

Next line to address issue #55

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

  process(data, instancename)
end
luamplib.process_mplibcode = process_mplibcode

```

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 ~= "" then
      if further_split_keys[k] 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

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

local function pdf_startfigure(n,llx,lly,urx,ury)
  texsprint(format("\\mplibstarttoPDF{%f}{%f}{%f}{%f}",llx,lly,urx,ury))
```

```
end

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

```

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

```
local function pdf_literalcode(fmt,...) -- table
  textprint({"\\mplibtoPDF{"},{-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
  end)
  texsprint(format("\\mplibtextext{%s}{%f}{%s}{%s}{%f}",font,size,text,0,-( 7200/ 7227)/65536*depth))
end

local bend_tolerance = 131/65536

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

local function pen_characteristics(object)
  local t = mplib.pen_info(object)
  rx, ry, sx, sy, tx, ty = t.rx, t.ry, t.sx, t.sy, t.tx, t.ty
  divider = sx*sy - rx*ry
  return not (sx==1 and rx==0 and ry==0 and sy==1 and tx==0 and ty==0), t.width
end

local function concat(px, py) -- no tx, ty here
  return (sy*px-ry*py)/divider,(sx*py-rx*px)/divider
end

local function curved(ith,pth)
  local d = pth.left_x - ith.right_x
  if abs(ith.right_x - ith.x_coord - d) <= bend_tolerance and abs(pth.x_coord - pth.left_x - d) <= bend_tolerance t
    d = pth.left_y - ith.right_y
    if abs(ith.right_y - ith.y_coord - d) <= bend_tolerance and abs(pth.y_coord - pth.left_y - d) <= bend_tolerance
      return false
    end
  end
  return true
end

local function flushnormalpath(path,open)
  local pth, ith
  for i=1,#path do
    pth = path[i]
    if not ith then
      pdf_literalcode("%f %f m",pth.x_coord,pth.y_coord)
    elseif curved(ith,pth) then
      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)
```

```
    else
      pdf_literalcode("%f %f l",pth.x_coord,pth.y_coord)
    end
    ith = pth
  end
  if not open then
    local one = path[1]
    if curved(pth,one) then
      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 )
    else
      pdf_literalcode("%f %f l",one.x_coord,one.y_coord)
    end
  elseif #path == 1 then -- special case .. draw point
    local one = path[1]
    pdf_literalcode("%f %f l",one.x_coord,one.y_coord)
  end
end

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

```

dvipdfmx is supported, though nobody seems to use it.

```
local pdfoutput = tonumber(texget("outputmode")) or tonumber(texget("pdfoutput"))
local pdfmode = pdfoutput > 0

local function start_pdf_code()
```

```
  if pdfmode then
    pdf_literalcode("q")
  else
    texsprint("\\special{pdf:bcontent}") -- dvipdfmx
  end
end
local function stop_pdf_code()
  if pdfmode then
    pdf_literalcode("Q")
  else
    texsprint("\\special{pdf:econtent}") -- dvipdfmx
  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)
    texsprint(format("\\mplibputtextbox{%i}",n))
    stop_pdf_code()
  end
end

```

Colors and Transparency

```
local pdfmanagement = is_defined'pdfmanagement_add:nnn'

local pdf_objs = {}
local getpageres, setpageres
local pgf = { bye = "pgfutil@everybye", extgs = "pgf@sys@addpdfresource@extgs@plain" }

if pdfmode then
  getpageres = pdf.getpageresources or function() return pdf.pageresources end
  setpageres = pdf.setpageresources or function(s) pdf.pageresources = s end
else
  texsprint("\\special{pdf:obj @MPlibTr<<>>}",
```

```
            "\\special{pdf:obj @MPlibSh<<>>}")
end

local function update_pdfobjs (os)
  local on = pdf_objs[os]
  if on then
    return on,false
  end
  if pdfmode then
    on = pdf.immediateobj(os)
  else
    on = pdf_objs.cnt or 0
    pdf_objs.cnt = on + 1
  end
  pdf_objs[os] = on
  return on,true
end

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(res,mode,opaq)
  local os = format("<</BM /%s/ca %.3f/CA %.3f/AIS false>>",mode,opaq,opaq)
  local on, new = update_pdfobjs(os)
  if new then
    if pdfmode then
      if pdfmanagement then
        texsprint(ccexplat,format(
        [[\pdfmanagement_add:nnn{Page/Resources/ExtGState}{MPlibTr%s}{%s 0 R}]],
        on,on))
      else
        res = format("%s/MPlibTr%i %i 0 R",res,on,on)
      end
    else
      if pdfmanagement then
        texsprint(ccexplat,format(
        [[\pdfmanagement_add:nnn{Page/Resources/ExtGState}{MPlibTr%s}{%s}]],
        on,os))
      elseif pgf.loaded then
        texsprint(format("\\csname %s\\endcsname{/MPlibTr%i%s}", pgf.extgs, on, os))
      else
        texsprint(format("\\special{pdf:put @MPlibTr<</MPlibTr%i%s>>}",on,os))
      end
    end
  end
  return res,on
end

local function tr_pdf_pageresources(mode,opaq)
```

```
  if not pgf.loaded and pgf.bye then
    pgf.loaded = is_defined(pgf.bye)
    pgf.bye    = pgf.loaded and pgf.bye
  end
  local res, on_on, off_on = "", nil, nil
  res, off_on = update_tr_res(res, "Normal", 1)
  res, on_on  = update_tr_res(res, mode, opaq)
  if pdfmanagement then return on_on, off_on end
  if pdfmode then
    if res ~= "" then
      if pgf.loaded then
        texsprint(format("\\csname %s\\endcsname{%s}", pgf.extgs, res))
      else
        local tpr, n = getpageres() or "", 0
        tpr, n = tpr:gsub("/ExtGState<<", "%1"..res)
        if n == 0 then
          tpr = format("%s/ExtGState<<%s>>", tpr, res)
        end
        setpageres(tpr)
      end
    end
  else
    if not pgf.loaded then
      texsprint(format("\\special{pdf:put @resources<</ExtGState @MPlibTr>>}"))
    end
  end
  return on_on, off_on
end

```

Shading with metafun format. (maybe legacy way)

```
local shading_res

local function shading_initialize ()
  shading_res = {}
  if pdfmode and luatexbase.callbacktypes.finish_pdffile then -- ltluatex
    local shading_obj = pdf.reserveobj()
    setpageres(format("%s/Shading %i 0 R",getpageres() or "",shading_obj))
    luatexbase.add_to_callback("finish_pdffile", function()
      pdf.immediateobj(shading_obj,format("<<%s>>",tableconcat(shading_res)))
      end, "luamplib.finish_pdffile")
    pdf_objs.finishpdf = true
  end
end

local function sh_pdfpageresources(shtype,domain,colorspace,colora,colorb,coordinates)
  if not pdfmanagement and not shading_res then shading_initialize() end
  local os = format("<</FunctionType 2/Domain [ %s ]/C0 [ %s ]/C1 [ %s ]/N 1>>",
                    domain, colora, colorb)
  local funcobj = pdfmode and format("%i 0 R",update_pdfobjs(os)) or os
  os = format("<</ShadingType %i/ColorSpace /%s/Function %s/Coords [ %s ]/Extend [ true true ]/AntiAlias true>>",
              shtype, colorspace, funcobj, coordinates)
  local on, new = update_pdfobjs(os)
  if pdfmode then
    if new then
```

```
      if pdfmanagement then
        texsprint(ccexplat,format(
        [[\pdfmanagement_add:nnn{Page/Resources/Shading}{MPlibSh%s}{%s 0 R}]],
        on,on))
      else
        local res = format("/MPlibSh%i %i 0 R", on, on)
        if pdf_objs.finishpdf then
          shading_res[#shading_res+1] = res
        else
          local pageres = getpageres() or ""
          if not pageres:find("/Shading<<.*>>") then
            pageres = pageres.."/Shading<<>>"
          end
          pageres = pageres:gsub("/Shading<<","%1"..res)
          setpageres(pageres)
        end
      end
    end
  else
    if pdfmanagement then
      if new then
        texsprint(ccexplat,format(
        [[\pdfmanagement_add:nnn{Page/Resources/Shading}{MPlibSh%s}{%s}]],
        on,os))
      end
    else
      if new then
        texsprint(format("\\special{pdf:put @MPlibSh<</MPlibSh%i%s>>}",on,os))
      end
      texsprint(format("\\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

local prev_override_color

local function do_preobj_color(object,prescript)
```

transparency

```
  local opaq = prescript and prescript.tr_transparency
  local tron_no, troff_no
  if opaq then
```

```
    local mode = prescript.tr_alternative or 1
    mode = transparancy_modes[tonumber(mode)]
    tron_no, troff_no = tr_pdf_pageresources(mode,opaq)
    pdf_literalcode("/MPlibTr%i gs",tron_no)
  end
```

color

```
  local override = prescript and prescript.MPlibOverrideColor
  if override then
    if pdfmode then
      pdf_literalcode(override)
      override = nil
    else
      if override:find"^pdf:" then
        texsprint(format("\\special{%s}",override))
      else
        texsprint(format("\\special{color push %s}",override))
      end
      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
        texsprint(format("\\special{color push %s}",override))
      end
    end
  end
```

shading

```
  local sh_type = prescript and prescript.sh_type
  if sh_type then
    local domain  = prescript.sh_domain
    local centera = prescript.sh_center_a:explode()
    local centerb = prescript.sh_center_b:explode()
    for _,t in pairs({centera,centerb}) do
      for i,v in ipairs(t) do
        t[i] = format("%f",v)
      end
    end
    centera = tableconcat(centera," ")
    centerb = tableconcat(centerb," ")
    local colora  = prescript.sh_color_a or {0};
    local colorb  = prescript.sh_color_b or {1};
    for _,t in pairs({colora,colorb}) do
      for i,v in ipairs(t) do
        t[i] = format("%.3f",v)
      end
    end
    if #colora > #colorb then
      color_normalize(colora,colorb)
```

```
    elseif #colorb > #colora then
      color_normalize(colorb,colora)
    end
    local colorspace
    if     #colorb == 1 then colorspace = "DeviceGray"
    elseif #colorb == 3 then colorspace = "DeviceRGB"
    elseif #colorb == 4 then colorspace = "DeviceCMYK"
    else   return troff_no,override
    end
    colora = tableconcat(colora, " ")
    colorb = tableconcat(colorb, " ")
    local shade_no
    if sh_type == "linear" then
      local coordinates = tableconcat({centera,centerb}," ")
      shade_no = sh_pdfpageresources(2,domain,colorspace,colora,colorb,coordinates)
    elseif sh_type == "circular" then
      local radiusa = format("%f",prescript.sh_radius_a)
      local radiusb = format("%f",prescript.sh_radius_b)
      local coordinates = tableconcat({centera,radiusa,centerb,radiusb}," ")
      shade_no = sh_pdfpageresources(3,domain,colorspace,colora,colorb,coordinates)
    end
    pdf_literalcode("q /Pattern cs")
    return troff_no,override,shade_no
  end
  return troff_no,override
end

local function do_postobj_color(tr,over,sh)
  if sh then
    pdf_literalcode("W n /MPlibSh%s sh Q",sh)
  end
  if over then
    texsprint("\\special{color pop}")
  end
  if tr then
    pdf_literalcode("/MPlibTr%i gs",tr)
  end
end

```

Finally, flush figures by inserting PDF literals.

```
local function 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()
```

```
1184        else
```

For legacy behavior. Insert 'pre-fig' TEX code here, and prepare a table for 'in-fig' codes.

```
1185          if tex_code_pre_mplib[f] then
1186            texsprint(tex_code_pre_mplib[f])
1187          end
1188          local TeX_code_bot = {}
1189          pdf_startfigure(fignum,llx,lly,urx,ury)
1190          start_pdf_code()
1191          if objects then
1192            local savedpath = nil
1193            local savedhtap = nil
1194            for o=1,#objects do
1195              local object       = objects[o]
1196              local objecttype   = object.type
```

The following 5 lines are part of btex...etex patch. Again, colors are processed at this stage.

```
1197              local prescript    = object.prescript
1198              prescript = prescript and script2table(prescript) -- prescript is now a table
1199              local tr_opaq,cr_over,shade_no = do_preobj_color(object,prescript)
1200              if prescript and prescript.mplibtexboxid then
1201                put_tex_boxes(object,prescript)
1202              elseif objecttype == "start_bounds" or objecttype == "stop_bounds" then --skip
1203              elseif objecttype == "start_clip" then
1204                local evenodd = not object.istext and object.postscript == "evenodd"
1205                start_pdf_code()
1206                flushnormalpath(object.path,false)
1207                pdf_literalcode(evenodd and "W* n" or "W n")
1208              elseif objecttype == "stop_clip" then
1209                stop_pdf_code()
1210                miterlimit, linecap, linejoin, dashed = -1, -1, -1, false
1211              elseif objecttype == "special" then
```

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

```
1212                if prescript and prescript.postmplibverbtex then
1213                  TeX_code_bot[#TeX_code_bot+1] = prescript.postmplibverbtex
1214                end
1215              elseif objecttype == "text" then
1216                local ot = object.transform -- 3,4,5,6,1,2
1217                start_pdf_code()
1218                pdf_literalcode("%f %f %f %f %f %f cm",ot[3],ot[4],ot[5],ot[6],ot[1],ot[2])
1219                pdf_textfigure(object.font,object.dsize,object.text,object.width,object.height,object.depth)
1220                stop_pdf_code()
1221              else
1222                local evenodd, collect, both = false, false, false
1223                local postscript = object.postscript
```

```
1224            if not object.istext then
1225              if postscript == ”evenodd” then
1226                evenodd = true
1227              elseif postscript == ”collect” then
1228                collect = true
1229              elseif postscript == ”both” then
1230                both = true
1231              elseif postscript == ”eoboth” then
1232                evenodd = true
1233                both    = true
1234              end
1235            end
1236            if collect then
1237              if not savedpath then
1238                savedpath = { object.path or false }
1239                savedhtap = { object.htap or false }
1240              else
1241                savedpath[#savedpath+1] = object.path or false
1242                savedhtap[#savedhtap+1] = object.htap or false
1243              end
1244            else
1245              local ml = object.miterlimit
1246              if ml and ml ~= miterlimit then
1247                miterlimit = ml
1248                pdf_literalcode(”%f M”,ml)
1249              end
1250              local lj = object.linejoin
1251              if lj and lj ~= linejoin then
1252                linejoin = lj
1253                pdf_literalcode(”%i j”,lj)
1254              end
1255              local lc = object.linecap
1256              if lc and lc ~= linecap then
1257                linecap = lc
1258                pdf_literalcode(”%i J”,lc)
1259              end
1260              local dl = object.dash
1261              if dl then
1262                local d = format(”[%s] %f d”,tableconcat(dl.dashes or {},” ”),dl.offset)
1263                if d ~= dashed then
1264                  dashed = d
1265                  pdf_literalcode(dashed)
1266                end
1267              elseif dashed then
1268                pdf_literalcode(”[] 0 d”)
1269                dashed = false
1270              end
1271              local path = object.path
1272              local transformed, penwidth = false, 1
1273              local open = path and path[1].left_type and path[#path].right_type
1274              local pen = object.pen
1275              if pen then
1276                if pen.type == ’elliptical’ then
1277                  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
```

Change from ConTeXt general: there was color stuffs.

```
              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
                end
              end
```

Added to ConTeXt general: color stuff. And execute legacy verbatimtex code.

```
              do_postobj_color(tr_opaq,cr_over,shade_no)
            end
          end
          stop_pdf_code()
          pdf_stopfigure()
          if #TeX_code_bot > 0 then texsprint(TeX_code_bot) end
        end
      end
    end
  end
end
luamplib.flush = flush

local function 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
```

```
luamplib.colorconverter = colorconverter
```

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}
    [2024/03/10 v2.26.4 mplib package for LuaTeX]
  \ifx\newluafunction\@undefined
  \input ltluatex
  \fi
\fi
```

Loading of lua code.

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

Support older engine. Seems we don't need it, but no harm.

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

Unfortuantely there are still packages out there that think it is a good idea to manually set `\pdfoutput` which defeats the above branch that defines `\pdfliteral`. To cover that case we need an extra check.

```
\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}{take dvipdfmx path, no support for other dvi tools currently.}
  \else
    \write128{}
    \write128{luamplib Info: take dvipdfmx path, no support for other dvi tools currently.}
    \write128{}
  \fi
\fi
```

Make `mplibcode` typesetted 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}}}
```

The Plain-specific stuff.

```
\unless\ifcsname ver@luamplib.sty\endcsname
\def\mplibcode{%
  \begingroup
  \begingroup
  \mplibsetupcatcodes
  \mplibdocode
}
\long\def\mplibdocode#1\endmplibcode{%
  \endgroup
  \directlua{luamplib.process_mplibcode([===[\unexpanded{#1}]===],"")}%
  \endgroup
}
\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

```
\protected\def\everymplib{%
  \begingroup
  \mplibsetupcatcodes
  \mplibdoeverymplib
}
\protected\def\everyendmplib{%
  \begingroup
  \mplibsetupcatcodes
  \mplibdoeveryendmplib
}
\ifcsname ver@luamplib.sty\endcsname
  \newcommand\mplibdoeverymplib[2][]{%
    \endgroup
    \directlua{
      luamplib.everymplib["#1"] = [===[\unexpanded{#2}]===]
    }%
  }
  \newcommand\mplibdoeveryendmplib[2][]{%
    \endgroup
    \directlua{
      luamplib.everyendmplib["#1"] = [===[\unexpanded{#2}]===]
    }%
  }
\else
  \long\def\mplibdoeverymplib#1{%
    \endgroup
    \directlua{
      luamplib.everymplib[""] = [===[\unexpanded{#1}]===]
    }%
  }
  \long\def\mplibdoeveryendmplib#1{%
```

```
    \endgroup
    \directlua{
      luamplib.everyendmplib[""] = [===[\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\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
\fi
```

That's all folks!

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