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 token lists `\everymplibtoks` and `\everyendmplibtoks` respectively, which will be automatically inserted at the beginning and ending of each mplib code.

```
\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, **(x)spotcolor** (in PDF mode) and **xespotcolor** (in DVI mode) packages are supported as well.

`\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, in the same directory as where pdf/dvi output file is saved. This 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.

\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       = "2.21.1",
5   date          = "2021/11/23",
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(...)
12   return luatexbase.module_error  ("luamplib", select("#",...) > 1 and format(...) or ...)
13 end
14 local warn = function(...)
15   return luatexbase.module_warning("luamplib", select("#",...) > 1 and format(...) or ...)
16 end
17 local info = function(...)
18   return luatexbase.module_info   ("luamplib", select("#",...) > 1 and format(...) or ...)
19 end
20
```

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

```
21 luamplib         = luamplib or { }
22 local luamplib    = luamplib
23
24 luamplib.showlog  = luamplib.showlog or false
25
```

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

```
26 local tableconcat   = table.concat
27 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 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]+$","")) .. "." .. suffix
end
local stripsuffix = file.stripsuffix or function(filename)
  return (filename:gsub("%.[%a%d]+$",""))
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.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
if lfstouch then
  local texmfvar = kpse.expand_var('$TEXMFVAR')
  if texmfvar and texmfvar ~= "" and texmfvar ~= '$TEXMFVAR' then
    for _,dir in next, texmfvar:explode(os.type == "windows" and ";" or ":") do
      if not lfsisdir(dir) then
        mk_full_path(dir)
      end
      if is_writable(dir) then
        local cached = format("%s/luamplib_cache",dir)
        lfsmkdir(cached)
        outputdir = cached
        break
      end
    end
  end
end
if not outputdir then
  outputdir = "."
  for _,v in ipairs(arg) do
    local t = v:match("%-output%-directory=(.+)")
    if t then
      outputdir = t
      break
    end
  end
end

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
        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,
}
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
    return name
  else
    ftype = special_ftype[ftype] or ftype
    local file = mpkpse:find_file(name,ftype)
    if file then
      if not lfstouch or ftype ~= "mp" or noneedtoreplace[name] then
        return file
      end
      return replaceinputmpfile(name,file)
    end
    return mpkpse:find_file(name, name:match("%a+$"))
  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,
    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 = {}
```

```
338
339 local function process (data)
```

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
```

```
340   local standalone = not luamplib.codeinherit
341   local currfmt = currentformat .. (luamplib.numbersystem or ”scaled”)
342     .. tostring(luamplib.textextlabel) .. tostring(luamplib.legacy_verbatimtex)
343   local mpx = mplibinstances[currfmt]
344   if mpx and standalone then
345     mpx:finish()
346   end
347   if standalone or not mpx then
348     mpx = luamplibload(currentformat)
349     mplibinstances[currfmt] = mpx
350   end
351   return process_indeed(mpx, data)
352 end
353
```

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

```
354 local catlatex = luatexbase.registernumber(”catcodetable@latex”)
355 local catat11  = luatexbase.registernumber(”catcodetable@atletter”)
356
```

`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
```

```
357 local function run_tex_code (str, cat)
358   cat = cat or catlatex
359   texruntoks(function() texsprint(cat, str) end)
360 end
361
```

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.

```
362 local tex_box_id = 2047
```

For conversion of sp to bp.

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

local textext_fmt = [[image(addto currentpicture doublepath unitsquare ]]..
  [[xscaled %f yscaled %f shifted (0,-%f) ]]..
  [[withprescript "mplibtexboxid=%i:%f:%f")]]

local function process_tex_text (str)
  if str then
    tex_box_id = tex_box_id + 1
    local global = luamplib.globaltextext and "\\global" or ""
    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.

```
local mplibcolor_fmt = [[\begingroup\let\XC@mcolor\relax]]..
  [[\def\set@color{\global\mplibtmptoks\expandafter{\current@color}}]]..
  [[\color %s \endgroup]]

local function process_color (str)
  if str then
    if not str:find("{.-}") then
      str = format("{%s}",str)
    end
    run_tex_code(mplibcolor_fmt:format(str), catat11)
    return format('1 withprescript "MPlibOverrideColor=%s"', texgettoks"mplibtmptoks")
  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 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 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

```

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

local function process_mplibcode (data)
```

This is needed for legacy behavior regarding `verbatimtex`

```
  legacy_mplibcode_reset()

  local everymplib    = texgettoks'everymplibtoks'    or ''
  local everyendmplib = texgettoks'everyendmplibtoks' or ''
  data = format("\n%s\n%s\n%s\n",everymplib, data, everyendmplib)
  data = data:gsub("\r","\n")
```

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

  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\\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)
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
```

```
723
724 local rx, sx, sy, ry, tx, ty, divider = 1, 0, 0, 1, 0, 0, 1
725
726 local function pen_characteristics(object)
727   local t = mplib.pen_info(object)
728   rx, ry, sx, sy, tx, ty = t.rx, t.ry, t.sx, t.sy, t.tx, t.ty
729   divider = sx*sy - rx*ry
730   return not (sx==1 and rx==0 and ry==0 and sy==1 and tx==0 and ty==0), t.width
731 end
732
733 local function concat(px, py) -- no tx, ty here
734   return (sy*px-ry*py)/divider,(sx*py-rx*px)/divider
735 end
736
737 local function curved(ith,pth)
738   local d = pth.left_x - ith.right_x
739   if abs(ith.right_x - ith.x_coord - d) <= bend_tolerance and abs(pth.x_coord - pth.left_x - d) <= bend_tolerance then
740     d = pth.left_y - ith.right_y
741     if abs(ith.right_y - ith.y_coord - d) <= bend_tolerance and abs(pth.y_coord - pth.left_y - d) <= bend_tolerance th
742       return false
743     end
744   end
745   return true
746 end
747
748 local function flushnormalpath(path,open)
749   local pth, ith
750   for i=1,#path do
751     pth = path[i]
752     if not ith then
753       pdf_literalcode("%f %f m",pth.x_coord,pth.y_coord)
754     elseif curved(ith,pth) then
755       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)
756     else
757       pdf_literalcode("%f %f l",pth.x_coord,pth.y_coord)
758     end
759     ith = pth
760   end
761   if not open then
762     local one = path[1]
763     if curved(pth,one) then
764       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 )
765     else
766       pdf_literalcode("%f %f l",one.x_coord,one.y_coord)
767     end
768   elseif #path == 1 then -- special case .. draw point
769     local one = path[1]
770     pdf_literalcode("%f %f l",one.x_coord,one.y_coord)
771   end
772 end
```

```
773
774 local function flushconcatpath(path,open)
775   pdf_literalcode("%f %f %f %f %f %f cm", sx, rx, ry, sy, tx ,ty)
776   local pth, ith
777   for i=1,#path do
778     pth = path[i]
779     if not ith then
780       pdf_literalcode("%f %f m",concat(pth.x_coord,pth.y_coord))
781     elseif curved(ith,pth) then
782       local a, b = concat(ith.right_x,ith.right_y)
783       local c, d = concat(pth.left_x,pth.left_y)
784       pdf_literalcode("%f %f %f %f %f %f c",a,b,c,d,concat(pth.x_coord, pth.y_coord))
785     else
786       pdf_literalcode("%f %f l",concat(pth.x_coord, pth.y_coord))
787     end
788     ith = pth
789   end
790   if not open then
791     local one = path[1]
792     if curved(pth,one) then
793       local a, b = concat(pth.right_x,pth.right_y)
794       local c, d = concat(one.left_x,one.left_y)
795       pdf_literalcode("%f %f %f %f %f %f c",a,b,c,d,concat(one.x_coord, one.y_coord))
796     else
797       pdf_literalcode("%f %f l",concat(one.x_coord,one.y_coord))
798     end
799   elseif #path == 1 then -- special case .. draw point
800     local one = path[1]
801     pdf_literalcode("%f %f l",concat(one.x_coord,one.y_coord))
802   end
803 end
804
```

dvipdfmx is supported, though nobody seems to use it.

```
805 local pdfoutput = tonumber(texget("outputmode")) or tonumber(texget("pdfoutput"))
806 local pdfmode = pdfoutput > 0
807
808 local function start_pdf_code()
809   if pdfmode then
810     pdf_literalcode("q")
811   else
812     texsprint("\\special{pdf:bcontent}") -- dvipdfmx
813   end
814 end
815 local function stop_pdf_code()
816   if pdfmode then
817     pdf_literalcode("Q")
818   else
819     texsprint("\\special{pdf:econtent}") -- dvipdfmx
820   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 pdf_objs = {}
local token, getpageres, setpageres = newtoken or token
local pgf = { bye = "pgfutil@everybye", extgs = "pgf@sys@addpdfresource@extgs@plain" }

if pdfmode then -- repect luaotfload-colors
  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
      res = format("%s/MPlibTr%i %i 0 R",res,on,on)
    else
      if 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 token and pgf.bye and not pgf.loaded then
    pgf.loaded = token.create(pgf.bye).cmdname == "assign_toks"
    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 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 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
    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
```

```
  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
  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
      texsprint(format("\\special{color push %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
      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()
```

```
        else
```

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

```
          if tex_code_pre_mplib[f] then
            texsprint(tex_code_pre_mplib[f])
          end
          local TeX_code_bot = {}
          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 5 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 tr_opaq,cr_over,shade_no = do_preobj_color(object,prescript)
          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
              TeX_code_bot[#TeX_code_bot+1] = prescript.postmplibverbtex
            end
          elseif objecttype == "text" then
            local ot = object.transform -- 3,4,5,6,1,2
            start_pdf_code()
            pdf_literalcode("%f %f %f %f %f %f cm",ot[3],ot[4],ot[5],ot[6],ot[1],ot[2])
            pdf_textfigure(object.font,object.dsize,object.text,object.width,object.height,object.depth)
            stop_pdf_code()
          else
            local evenodd, collect, both = false, false, false
            local postscript = object.postscript
            if not object.istext then
              if postscript == "evenodd" then
                evenodd = true
              elseif postscript == "collect" then
                collect = true
              elseif postscript == "both" then
                both = true
              elseif postscript == "eoboth" then
                evenodd = true
                both    = true
              end
            end
            if collect then
```

```
    if not savedpath then
      savedpath = { object.path or false }
      savedhtap = { object.htap or false }
    else
      savedpath[#savedpath+1] = object.path or false
      savedhtap[#savedhtap+1] = object.htap or false
    end
  else
    local ml = object.miterlimit
    if ml and ml ~= miterlimit then
      miterlimit = ml
      pdf_literalcode("%f M",ml)
    end
    local lj = object.linejoin
    if lj and lj ~= linejoin then
      linejoin = lj
      pdf_literalcode("%i j",lj)
    end
    local lc = object.linecap
    if lc and lc ~= linecap then
      linecap = lc
      pdf_literalcode("%i J",lc)
    end
    local dl = object.dash
    if dl then
      local d = format("[%s] %f d",tableconcat(dl.dashes or {}," "),dl.offset)
      if d ~= dashed then
        dashed = d
        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
```

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
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}
    [2021/11/23 v2.21.1 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 warning.

```
\ifnum\pdfoutput>0
  \let\mplibtoPDF\pdfliteral
\else
  \def\mplibtoPDF#1{\special{pdf:literal direct #1}}
  \ifcsname PackageWarning\endcsname
    \PackageWarning{luamplib}{take dvipdfmx path, no support for other dvi tools currently.}
  \else
    \write128{}
    \write128{luamplib Warning: 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}{%
  \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]===])}%
    \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 redefining \everymplibtoks & \everyendmplibtoks respectively

```
\newtoks\everymplibtoks
\newtoks\everyendmplibtoks
\protected\def\everymplib{%
  \begingroup
  \mplibsetupcatcodes
  \mplibdoeverymplib
}
\long\def\mplibdoeverymplib#1{%
  \endgroup
  \everymplibtoks{#1}%
}
\protected\def\everyendmplib{%
  \begingroup
  \mplibsetupcatcodes
  \mplibdoeveryendmplib
}
\long\def\mplibdoeveryendmplib#1{%
  \endgroup
```

```
  \everyendmplibtoks{#1}%
}
```

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{ mplibdimen("#1") }
\def\mpcolor#1#{\domplibcolor{#1}}
\def\domplibcolor#1#2{ mplibcolor("#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{%
  \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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