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 cuations 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.

\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, 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, users cannot use \mpdim, but \mpcolor is OK. All other TEX commands outside btex ... etex or verbatimtex ... etex are not expanded and will be fed literally into the mplib process.

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       = "2.20.0",
5   date          = "2019/03/20",
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", format(...)) end
12 local warn = function(...) return luatexbase.module_warning("luamplib", format(...)) end
13 local info = function(...) return luatexbase.module_info   ("luamplib", format(...)) end
14
```

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

```
15 luamplib         = luamplib or { }
16 local luamplib    = luamplib
17
18 luamplib.showlog  = luamplib.showlog or false
19 luamplib.lastlog  = ""
20
```

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

```
21 local tableconcat   = table.concat
22 local texsprint     = tex.sprint
23 local textprint     = tex.tprint
24
25 local texget      = tex.get
26 local texgettoks  = tex.gettoks
27 local texgetbox   = tex.getbox
28 local texruntoks  = tex.runtoks
29 local texscantoks = tex.scantoks
30
31 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 '"..dir.."' is not writable!")
      end
    else
      warn("Directory '"..dir.."' does not exist!")
    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-Z_a-z]"
local name_e = "%f[^A-Z_a-z]"
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.

```
local mpkpse = kpse.new(arg[0], "mpost")

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-zA-Z]+$"))
  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 function luamplibresetlastlog()
  luamplib.lastlog = ""
end

local function reporterror (result)
  if not result then
    err("no result object returned")
  else
    local t, e, l = result.term, result.error, result.log
    local log = t or l or "no-term"
    log = log:gsub("^%s+","\n")
    luamplib.lastlog = luamplib.lastlog .. "\n" .. (l or t or "no-log")
    if result.status > 0 then
      warn("%s",log)
      if result.status > 1 then
        err("%s",e or "see above messages")
      end
    end
    return log
  end
end

```

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

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

```
    make_text   = luamplib.maketext,
    run_script  = luamplib.runscript,
    math_mode   = luamplib.numbersystem,
    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)
    if log then
      if luamplib.showlog then
        info("%s",luamplib.lastlog)
```

```
      luamplibresetlastlog()
    elseif result.fig then
```

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 info("%s",log) end
      converted = luamplib.convert(result)
    else
      info("%s",log)
      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)
```

Workaround issue #70

```
 if not data:find(name_b.."beginfig%s*%([%+%-%s]*%d[%.%d%s]*%)") then
  data = data .. "beginfig(-1);endfig;"
 end
 local standalone = not luamplib.codeinherit
 local currfmt = currentformat .. (luamplib.numbersystem or "scaled")
  .. tostring(luamplib.textextlabel) .. tostring(luamplib.legacy_verbatimtex)
 local mpx = mplibinstances[currfmt]
 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)

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 format("image(addto currentpicture doublepath unitsquare "..
    "xscaled %f yscaled %f shifted (0,-%f) "..
    "withprescript \"mplibtexboxid=%i:%f:%f\")",
    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`

```
local function process_color (str)
  if str then
    if not str:find("{.-}") then
      str = format("{%s}",str)
    end
    run_tex_code(format(
      "\\def\\set@color{\\toks0\\expandafter{\\current@color}}\\color %s", str),
      catat11)
    return format("1 withprescript \"MPlibOverrideColor=%s\"", texgettoks(0))
  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("\\toks0\\expandafter{\\the\\dimexpr %s\\relax}", str))
    return format("begingroup %s endgroup", texgettoks(0))
  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,
}

```

As of 2019-03, `metafun` format is not usable (issue #79). This might workarounds the problem.

```
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
LUATEXFUNCTIONALITY = LUATEXFUNCTIONALITY or 0

```

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] = "(" .. concat(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 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()
    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&
  "luamplib.in_the_fig=false luamplib.figid=luamplib.figid+1" &ditto& ");";
]]
luamplib.legacyverbatimtexpreamble = legacyverbatimtexpreamble

local textextlabelpreamble = [[
primarydef s infont f = rawtextext(s) enddef;
```

```
def fontsize expr f =
  begingroup
  save size,pic; numeric size; picture pic;
  pic := rawtextext("\hskip\pdffontsize\font");
  size := xpart urcorner pic - xpart llcorner pic;
  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("\\","\1Control\1")
             :gsub("%%","\1Comment\1")
             :gsub("#", "\1HashSign\1")
             :gsub("{", "\1LBrace\1")
             :gsub("}", "\1RBrace\1")
    return format("\\unexpanded{%s}",str)
  end
end

local function unprotect_expansion (str)
  if str then
    return str:gsub("\1Control\1", "\\")
              :gsub("\1Comment\1", "%%")
              :gsub("\1HashSign\1","#")
              :gsub("\1LBrace\1",  "{")
              :gsub("\1RBrace\1",  "}")
  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(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("%%.-\n","")
   run_tex_code(format("\\toks0\\expanded{{%s}}",data))
   data = texgettoks(0)
```

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

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
```

```
703
704 local function curved(ith,pth)
705   local d = pth.left_x - ith.right_x
706   if abs(ith.right_x - ith.x_coord - d) <= bend_tolerance and abs(pth.x_coord - pth.left_x - d) <= bend_tolerance then
707     d = pth.left_y - ith.right_y
708     if abs(ith.right_y - ith.y_coord - d) <= bend_tolerance and abs(pth.y_coord - pth.left_y - d) <= bend_tolerance th
709       return false
710     end
711   end
712   return true
713 end
714
715 local function flushnormalpath(path,open)
716   local pth, ith
717   for i=1,#path do
718     pth = path[i]
719     if not ith then
720       pdf_literalcode("%f %f m",pth.x_coord,pth.y_coord)
721     elseif curved(ith,pth) then
722       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)
723     else
724       pdf_literalcode("%f %f l",pth.x_coord,pth.y_coord)
725     end
726     ith = pth
727   end
728   if not open then
729     local one = path[1]
730     if curved(pth,one) then
731       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 )
732     else
733       pdf_literalcode("%f %f l",one.x_coord,one.y_coord)
734     end
735   elseif #path == 1 then -- special case .. draw point
736     local one = path[1]
737     pdf_literalcode("%f %f l",one.x_coord,one.y_coord)
738   end
739 end
740
741 local function flushconcatpath(path,open)
742   pdf_literalcode("%f %f %f %f %f %f cm", sx, rx, ry, sy, tx ,ty)
743   local pth, ith
744   for i=1,#path do
745     pth = path[i]
746     if not ith then
747       pdf_literalcode("%f %f m",concat(pth.x_coord,pth.y_coord))
748     elseif curved(ith,pth) then
749       local a, b = concat(ith.right_x,ith.right_y)
750       local c, d = concat(pth.left_x,pth.left_y)
751       pdf_literalcode("%f %f %f %f %f %f c",a,b,c,d,concat(pth.x_coord, pth.y_coord))
752     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 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
```

```
1077            elseif objecttype == "start_clip" then
1078              local evenodd = not object.istext and object.postscript == "evenodd"
1079              start_pdf_code()
1080              flushnormalpath(object.path,false)
1081              pdf_literalcode(evenodd and "W* n" or "W n")
1082            elseif objecttype == "stop_clip" then
1083              stop_pdf_code()
1084              miterlimit, linecap, linejoin, dashed = -1, -1, -1, false
1085            elseif objecttype == "special" then
```

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

```
1086              if prescript and prescript.postmplibverbtex then
1087                TeX_code_bot[#TeX_code_bot+1] = prescript.postmplibverbtex
1088              end
1089            elseif objecttype == "text" then
1090              local ot = object.transform -- 3,4,5,6,1,2
1091              start_pdf_code()
1092              pdf_literalcode("%f %f %f %f %f %f cm",ot[3],ot[4],ot[5],ot[6],ot[1],ot[2])
1093              pdf_textfigure(object.font,object.dsize,object.text,object.width,object.height,object.depth)
1094              stop_pdf_code()
1095            else
1096              local evenodd, collect, both = false, false, false
1097              local postscript = object.postscript
1098              if not object.istext then
1099                if postscript == "evenodd" then
1100                  evenodd = true
1101                elseif postscript == "collect" then
1102                  collect = true
1103                elseif postscript == "both" then
1104                  both = true
1105                elseif postscript == "eoboth" then
1106                  evenodd = true
1107                  both    = true
1108                end
1109              end
1110              if collect then
1111                if not savedpath then
1112                  savedpath = { object.path or false }
1113                  savedhtap = { object.htap or false }
1114                else
1115                  savedpath[#savedpath+1] = object.path or false
1116                  savedhtap[#savedhtap+1] = object.htap or false
1117                end
1118              else
1119                local ml = object.miterlimit
1120                if ml and ml ~= miterlimit then
1121                  miterlimit = ml
1122                  pdf_literalcode("%f M",ml)
1123                end
1124                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
  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

⟨∗**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}
    [2019/03/20 v2.20.0 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\scantextokens\undefined
  \let\scantextokens\luatexscantextokens
\fi
\ifx\pdfoutput\undefined
  \let\pdfoutput\outputmode
  \protected\def\pdfliteral{\pdfextension literal}
  \def\pdffontsize{\dimexpr\pdffeedback fontsize\relax}
\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\mplibhmodeornot\leavevmode}
\def\mplibnoforcehmode{\let\mplibhmodeornot\relax}
\mplibnoforcehmode
```

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

```
\def\mplibsetupcatcodes{%
  \mplibhmodeornot %catcode`\{=12 %catcode`\}=12
  \catcode`\#=12 \catcode`\^=12 \catcode`\~=12 \catcode`\_=12
  \catcode`\&=12 \catcode`\$=12 \catcode`\%=12 \catcode`\^^M=12 \endlinechar=10
}
```

Make btex...etex box zero-metric.

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

As we have changed `^^J` catcode, the last line containing `\end{mplibcode}` has `\n` at the end. Replace it with `^^M`.

```
\newcount\mplibstartlineno
\def\mplibpostmpcatcodes{%
```

```
  \catcode`\{=12 \catcode`\}=12 \catcode`\#=12 \catcode`\%=12 }
\def\mplibreplacenewlinebr{%
  \begingroup \mplibpostmpcatcodes \mplibdoreplacenewlinebr}
\begingroup\lccode`\~=`\^^M \lowercase{\endgroup
  \def\mplibdoreplacenewlinebr#1^^J{\endgroup\scantextokens{{}#1~}}}
```

The Plain-specific stuff.

```
\bgroup\expandafter\expandafter\expandafter\egroup
\expandafter\ifx\csname selectfont\endcsname\relax
\def\mplibreplacenewlinecs{%
  \begingroup \mplibpostmpcatcodes \mplibdoreplacenewlinecs}
\begingroup\lccode`\~=`\^^M \lowercase{\endgroup
  \def\mplibdoreplacenewlinecs#1^^J{\endgroup\scantextokens{\relax#1~}}}
\def\mplibcode{%
  \mplibstartlineno\inputlineno
  \begingroup
  \begingroup
  \mplibsetupcatcodes
  \mplibdocode
}
\long\def\mplibdocode#1\endmplibcode{%
  \endgroup
  \directlua{luamplib.process_mplibcode([===[\unexpanded{#1}]===])}%
  \endgroup
  \ifnum\mplibstartlineno<\inputlineno\expandafter\mplibreplacenewlinecs\fi
}
\else
```

The LaTeX-specific part: a new environment.

```
\newenvironment{mplibcode}{%
  \global\mplibstartlineno\inputlineno
  \toks@{}\ltxdomplibcode
}{}
\def\ltxdomplibcode{%
  \begingroup
  \mplibsetupcatcodes
  \ltxdomplibcodeindeed
}
\def\mplib@mplibcode{mplibcode}
\long\def\ltxdomplibcodeindeed#1\end#2{%
  \endgroup
  \toks@\expandafter{\the\toks@#1}%
  \def\mplibtemp@a{#2}%
  \ifx\mplib@mplibcode\mplibtemp@a
    \directlua{luamplib.process_mplibcode([===[\the\toks@]===])}%
    \end{mplibcode}%
    \ifnum\mplibstartlineno<\inputlineno
      \expandafter\expandafter\expandafter\mplibreplacenewlinebr
    \fi
  \else
    \toks@\expandafter{\the\toks@\end{#2}}\expandafter\ltxdomplibcode
```

```
  \fi
}
\fi
```

User settings.

```
\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
}}
```

`\everymplib` & `\everyendmplib`: macros redefining `\everymplibtoks` & `\everyendmplibtoks` respectively

```
\newtoks\mplibtmptoks
\newtoks\everymplibtoks
\newtoks\everyendmplibtoks
\protected\def\everymplib{%
  \mplibstartlineno\inputlineno
  \begingroup
  \mplibsetupcatcodes
  \mplibdoeverymplib
}
\long\def\mplibdoeverymplib#1{%
  \endgroup
  \everymplibtoks{#1}%
  \ifnum\mplibstartlineno<\inputlineno\expandafter\mplibreplacenewlinebr\fi
}
\protected\def\everyendmplib{%
  \mplibstartlineno\inputlineno
  \begingroup
  \mplibsetupcatcodes
  \mplibdoeveryendmplib
}
\long\def\mplibdoeveryendmplib#1{%
  \endgroup
  \everyendmplibtoks{#1}%
  \ifnum\mplibstartlineno<\inputlineno\expandafter\mplibreplacenewlinebr\fi
}
```

Allow TEX dimen macros in `mplibcode`.

```
\def\mpdim#1{ begingroup \the\dimexpr #1\relax\space endgroup } % gmp.sty
```

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{%
  \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!

```
⟨/package⟩
```

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End of Terms and Conditions

Appendix: How to Apply These Terms to Your New Programs

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>
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