

Morphing Optimisation



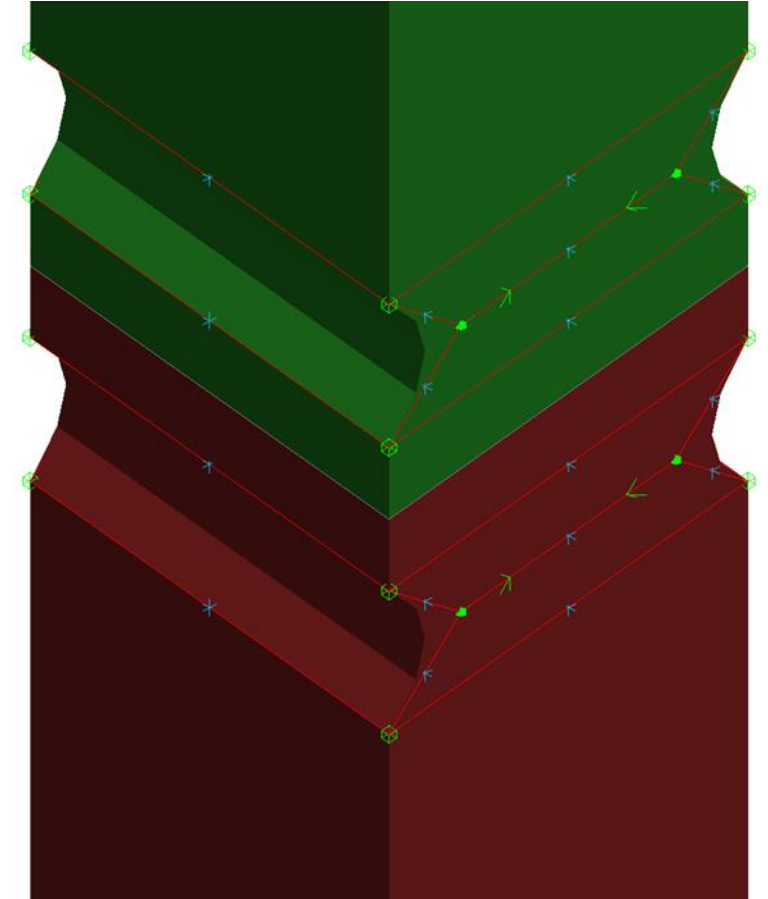
Parametrising morphing

- This tutorial explains how morphing can be parametrised and controlled from command line arguments.
- In particular this can be used with LS-OPT to find variable values controlling the shape of a mesh to optimise user-defined objectives, for example accelerations.
- Knowledge of the basic morphing functionality is assumed. It is described in the Morphing tutorial.



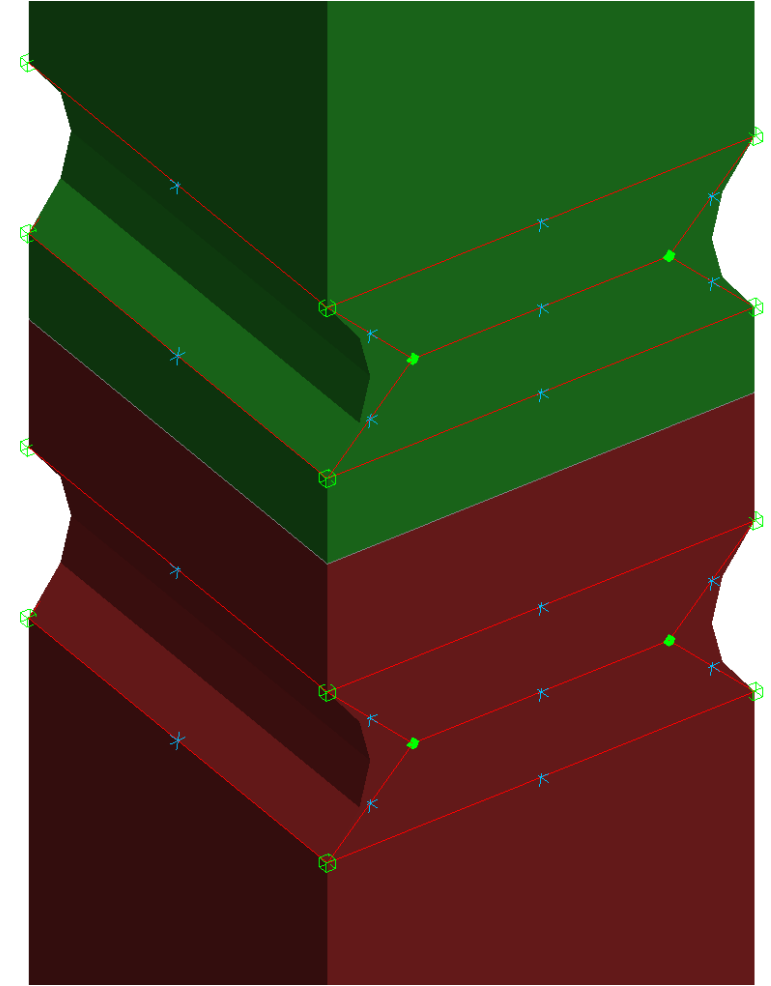
Morph flows

- A morph flow can be thought of a list of morph points with a vector for each point. This shows how the morph points “flow” when a variable value is applied.
- After *END each flow is written out as keyword *MORPH_FLOW, which ensures that it can be used in future PRIMER sessions, in particular when PRIMER starts from the command line applying variables as described on the next slides.



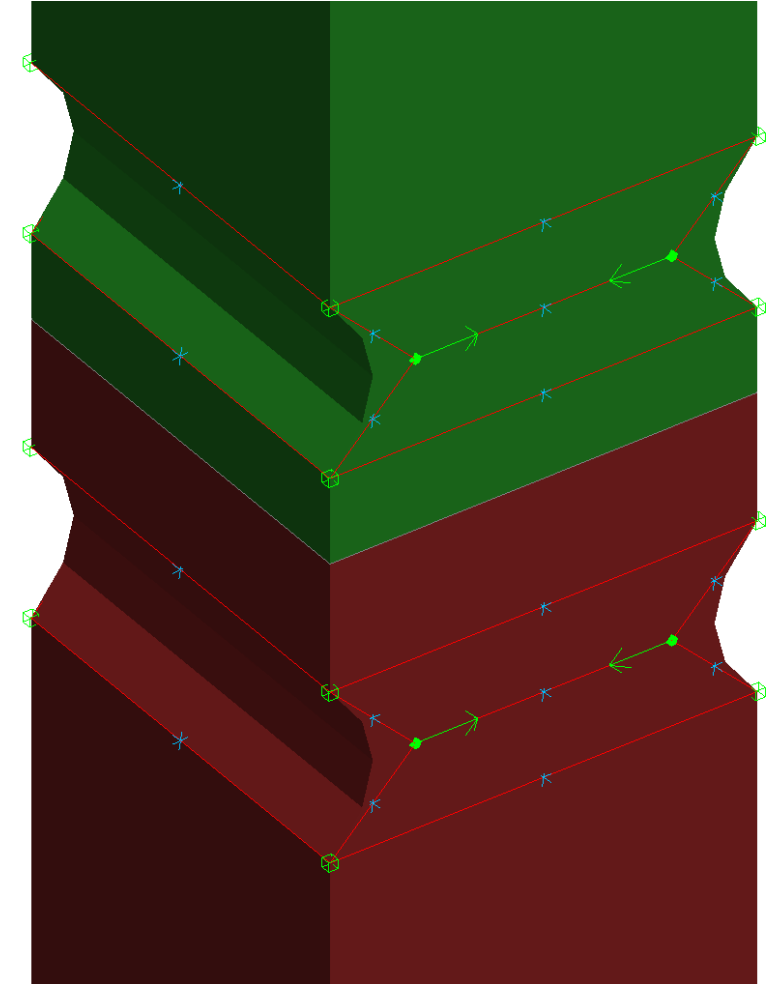
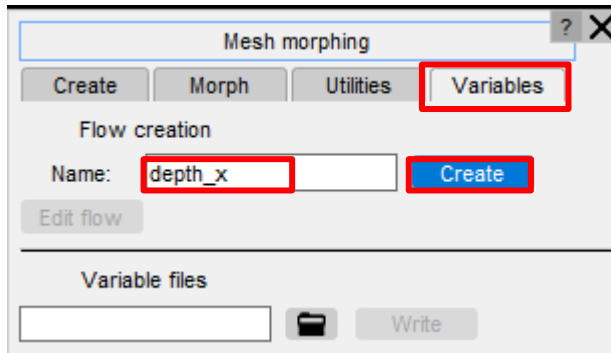
Defining a morph flow

- You first need a model with morph box(es). If you haven't got this already, please refer to the other Morphing tutorials.
- Morph the box(es) how you wish them to look when a variable is applied. This can be done with the interactive functions on the Morph tab. Also the numerical offset vector input can be useful to ensure symmetry.
- For each morph point moved from its original position, its total movement vector up to scaling is what will be used for the morph flow definition.



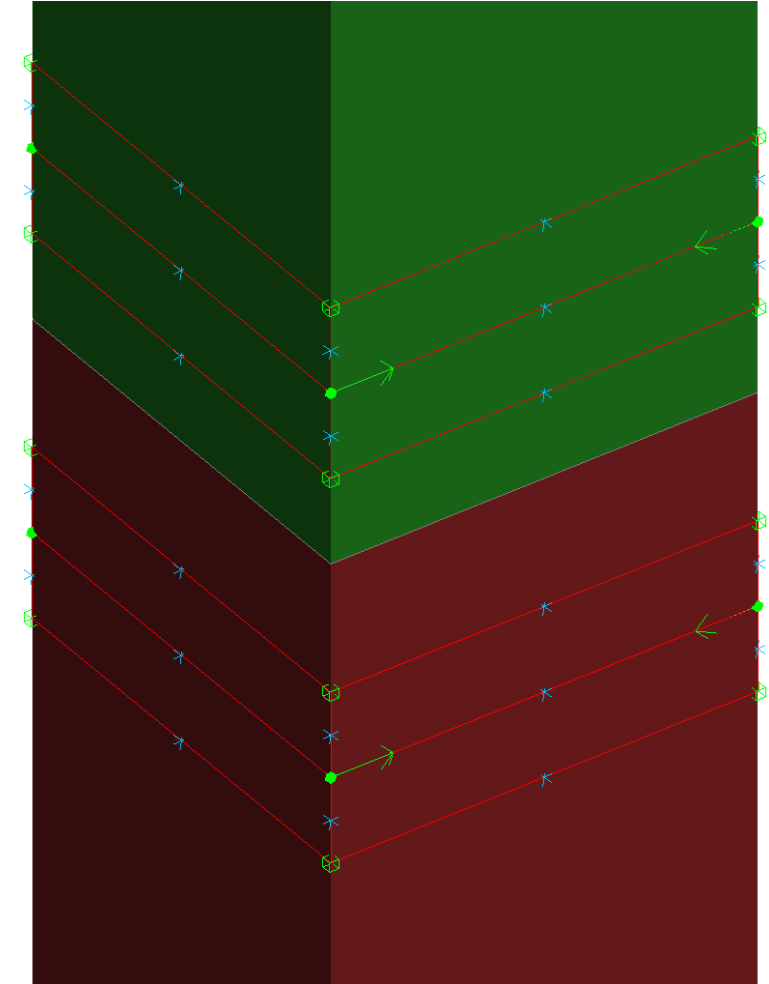
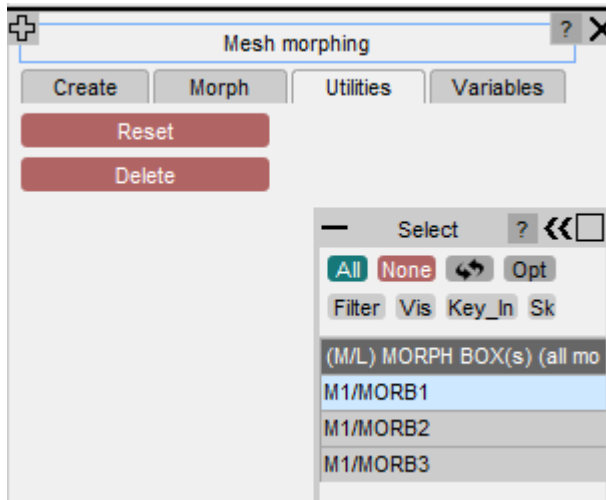
Defining a morph flow

- Go to the Variables tab.
- Fill in a unique name for the morph flow. This is used to refer to the morph flow from a design variable file (explained below). When you intend to run an optimisation from LS-OPT, it is a good idea to use the variable name to be used there as the morph flow name.
- Press the Create button. On the new morph flow all moved points appear with the unit vector along which they have moved from the original position.



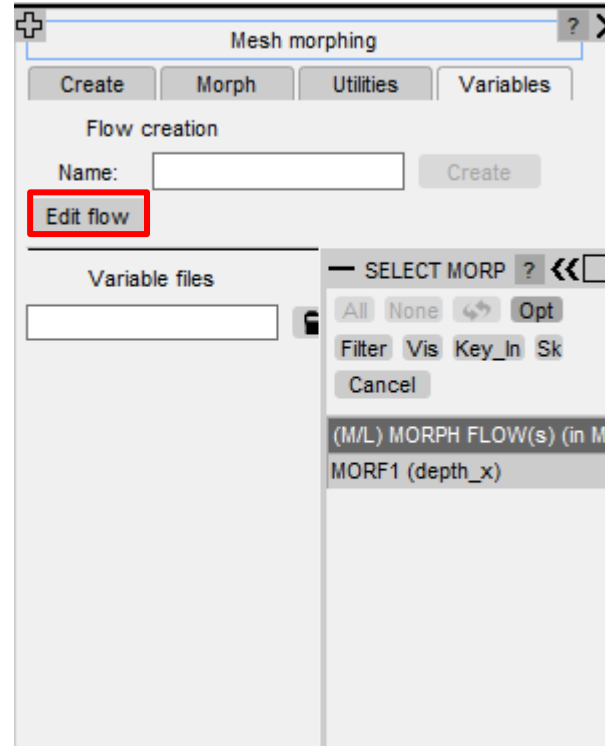
Resetting boxes

- If you like to create other morph flows, reset all morph box(es) in the Utilities tab. Otherwise you might get unexpected results with the same morph point movements appearing on multiple flows.
- Also when you write the model with all morph flows, reset all boxes. This ensures that the variables are applied from the expected initial morph point positions.



Editing morph flows

- The “Edit flow” button allows editing the existing morph flows.



Editing morph flows

- After selecting the morph flow, you can edit the name, some variable range information (which is only there for future development but not currently used in PRIMER 16) and the list of morph points with the vectors.

MODIFY MORPH FLOW M1/MORF1

☒ Check

Include:

MORPH FLOW

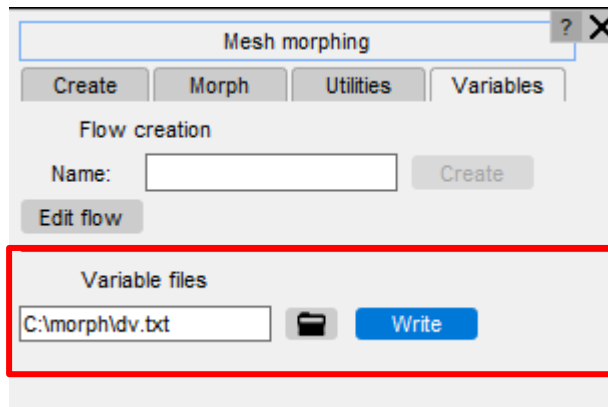
1	name	Char						
	depth_x							
2	type	Char	min	Ft	max	Ft		
	CONTINUOUS		-2.9403954		2.9403954			

Open ended lines below

3	point1	MORP	dx1	Ft	dy1	Ft	dz1	Ft										
	1	▼	-1.3816E-5		0.0		0.58878475											
4	point2	MORP	dx2	Ft	dy2	Ft	dz2	Ft										
	2	▼	-1.3816E-5		0.0		1.14249E-6											
5	point3	MORP	dx3	Ft	dy3	Ft	dz3	Ft										
	3	▼	-1.3816E-5		0.0		0.58878475											
6	point4	MORP	dx4	Ft	dy4	Ft	dz4	Ft										
	4	▼	-1.3816E-5		0.0		1.14249E-6											
7	point5	MORP	dx5	Ft	dy5	Ft	dz5	Ft										
	5	▼	1.51446E-5		0.0		0.58878475											
8	point6	MORP	dx6	Ft	dy6	Ft	dz6	Ft										
	6	▼	1.51446E-5		0.0		1.14249E-6											
9	point7	MORP	dx7	Ft	dy7	Ft	dz7	Ft										
	7	▼	1.51446E-5		0.0		0.58878475											
10	point8	MORP	dx8	Ft	dy8	Ft	dz8	Ft										
	8	▼	1.51446E-5		0.0		1.14249E-6											
11	point9	MORP	dx9	Ft	dy9	Ft	dz9	Ft										
	9	▼	0.0		-2.657E-7		4.38398E-6											
12	point10	MORP	dx10	Ft	dy10	Ft	dz10	Ft										
	10	▼	0.0		-2.657E-7		1.2687E-5											
13	point11	MORP	dx11	Ft	dy11	Ft	dz11	Ft										
	11	▼	0.0		-1.3019E-6		4.38398E-6											
14	point12	MORP	dx12	Ft	dy12	Ft	dz12	Ft										
	12	▼	0.0		-1.3019E-6		1.2687E-5											

Design variable files

- The Variables tab allows you to write a JSON design variable file with an entry for each morph flow.
- The “name” property is what you have specified in the morph flow creation.
- The “value” property is always written as 0. Inserting other values will control how far the morph points on the corresponding morph flow will move when the morphing is applied.
- The “type” property will be “CONTINUOUS” (default), “STEP” or “DISCRETE”. It is not currently used, but has only been added for future development.



```
[
  {
    "name": "depth_x",
    "type": "CONTINUOUS",
    "value": 0,
    "minimum": -20,
    "maximum": 40
  },
  {
    "name": "depth_y",
    "type": "CONTINUOUS",
    "value": 0,
    "minimum": -20,
    "maximum": 40
  }
]
```

Morphing from command line arguments

- To apply morphing from the command line, you need the following:
- In the design variable file you will need to insert the values in the “value” properties. All morph points on the flow with the corresponding name will move by the vector defined on the flow multiplied by that value, which can be thought of length.
- The command has got the syntax:

<PRIMER executable path> <input .key file> -ls_opt=<design variable file> -ls_opt_arg=<optional argument> -exit



OUTPUT: <output filename>
REMAKE_CONX: <TRUE/FALSE>
REMAKE_CONX_ERROR: <TRUE/FALSE>



Morphing from command line arguments

<PRIMER executable path> <input .key file> -ls_opt=<design variable file> -ls_opt_arg=<optional argument> -exit

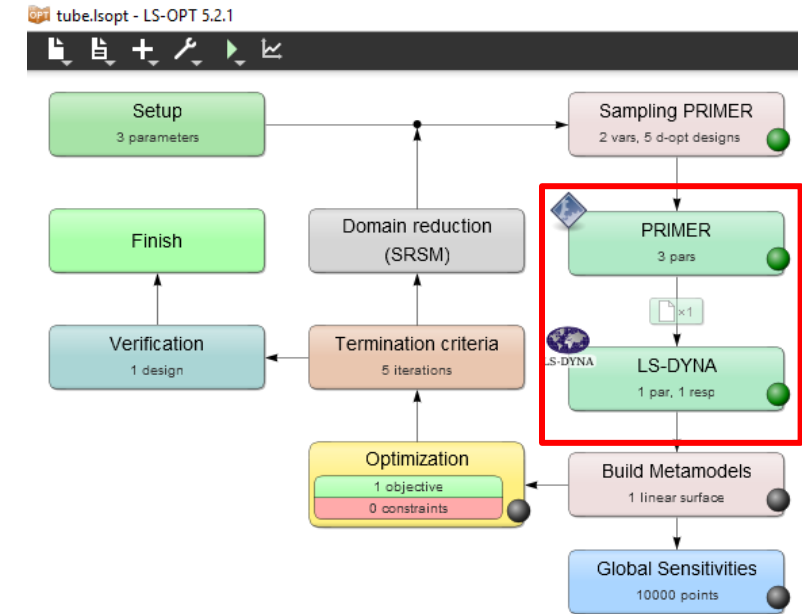
OUTPUT: <output filename>
REMAKE_CONX: <TRUE/FALSE>
REMAKE_CONX_ERROR: <TRUE/FALSE>

- OUTPUT - If omitted, the input file will be overwritten.
 - REMAKE_CONX – Whether to remake of connections after morphing (default: TRUE).
 - REMAKE_CONX_ERROR – Failure to remake an initially realized connection will result in an Error Termination (default: TRUE).
 - If no argument name is given, the value is assumed to be the output filename.
 - E.g. -ls_opt_arg="OUTPUT: filename.key" -ls_opt_arg="REMAKE_CONX: TRUE"
- This command can be run from any command prompt or .bat file. On the following slides we will see how to use it in LS-OPT.



Stages in LS-OPT

- The flowchart on the right shows a possible layout of stages in LS-OPT.
- There should be two stages PRIMER and LS-DYNA after each other. When the pre-processor stage PRIMER is defined, LS-DYNA can be added as a new stage in PRIMER, and the stage dependency arrow can then be dragged.
- Later slides give more detail about the setup of the individual stages.



Inserting LS-OPT parameters

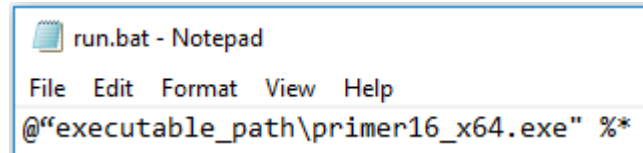
- Edit dv.txt in your working directory such that the “value” properties are <<variable_name>>, i.e. the LS-OPT variable name in <<>> brackets. This variable name can be identical to the morph flow name. Make sure that the line in the JSON file is still terminated by a comma, but there are no quotes except for those around “value”.

```
[
  {
    "name": "depth_x",
    "type": "CONTINUOUS",
    "value": <<depth_x>>,
    "minimum": -20,
    "maximum": 40
  },
  {
    "name": "depth_y",
    "type": "CONTINUOUS",
    "value": <<depth_y>>,
    "minimum": -20,
    "maximum": 40
  }
]
```

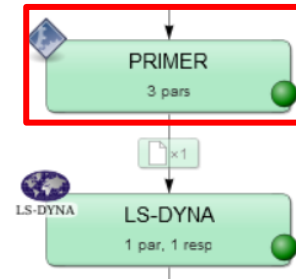


Pre-processor stage in LS-OPT

- For Windows create a text file run.bat containing the following:
- @“executable_path\primer16_x64.exe” %*



- As command in the LS-OPT pre-processor stage definition on Windows fill in:
- `working_directory\run.bat –noconsole –exec your_input_file.key –ls_opt=PrimerOpt.inp –exit`
- When running on Linux, specify the PRIMER executable path directly instead of run.bat and without –noconsole or –exec:
- `executable_path\primer16_x64.exe your_input_file.key –ls_opt=PrimerOpt.inp –exit`



Stage PRIMER

Setup Parameters Histories Responses File Operations

General

Package Name: User-Defined

Command: C:\morph\tutorial\run.bat -noconsole -exec tube.key -ls_opt=PrimerOpt.inp -exit Browse

☒ Do not add input file argument

Input File: dv.txt Browse

copies dv.txt (0 includes) to PRIMER/it.run/ PrimerOpt.inp (default is UserOpt.inp) and substitutes parameters

☒ Extra input files

Filename	Parse	Delete
tube.key Browse	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

[Add](#)

Execution

Resources

Resource	Units per job	Global limit	Delete
USERDEFINED	1	1	<input checked="" type="checkbox"/>

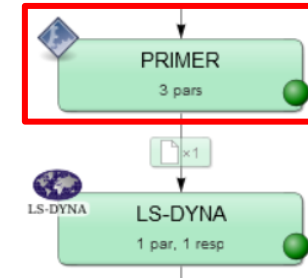
[Create new resource](#)

☐ Use Queuing
☐ Use LSTCVM proxy
☐ Environment Variables
☐ Run Jobs in Directory of Stage

Advanced execution options

Pre-processor stage in LS-OPT

- Optionally use -batch instead of the -exit for the PRIMER command if you wish to avoid PRIMER windows appearing on the screen.
- Tick “Do not add input file argument”.
- As input file specify dv.txt.
- As target on the line “copies dv.txt ...”, which by default says UserOpt.inp, specify the file name PrimerOpt.inp.



Stage PRIMER

Setup Parameters Histories Responses File Operations

General

Package Name User-Defined

Command C:\morph\tutorial\run.bat -noconsole -exec tube.key -ls_opt=PrimerOpt.inp -exit Browse

☒ Do not add input file argument

Input File dv.txt Browse

copies dv.txt (0 includes) to PRIMER/it.run/ PrimerOpt.inp (default is UserOpt.inp) and substitutes parameters

☒ Extra input files

Filename	Parse	Delete
tube.key Browse	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

[Add](#)

Execution

Resources

Resource	Units per job	Global limit	Delete
USERDEFINED	1	1	<input checked="" type="checkbox"/>

[Create new resource](#)

☐ Use Queuing

☐ Use LSTCVM proxy

☐ Environment Variables

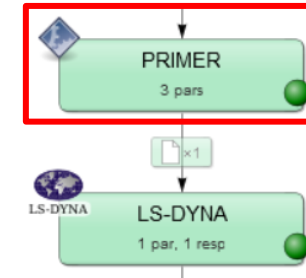
☐ Run Jobs in Directory of Stage

Advanced execution options

Pre-processor stage in LS-OPT

- Tick “Extra input files” and add your_input_file.key.
- Tick the box to parse that extra input file.

PRIMER



Stage PRIMER

Setup Parameters Histories Responses File Operations

General

Package Name: User-Defined

Command: C:\morph\tutorial\run.bat -noconsole -exec tube.key -ls_opt=PrimerOpt.inp -exit Browse

☒ Do not add input file argument

Input File: dv.txt Browse

copies dv.txt (0 includes) to PRIMER/it.run/ PrimerOpt.inp (default is UserOpt.inp) and substitutes parameters

☒ Extra input files

Filename	Parse	Delete
tube.key Browse	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Add		

Execution

Resources

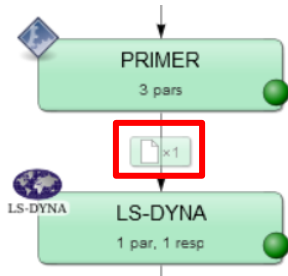
Resource	Units per job	Global limit	Delete
USERDEFINED	1	1	<input checked="" type="checkbox"/>
Create new resource			

☐ Use Queuing
☐ Use LSTCVM proxy
☐ Environment Variables
☐ Run Jobs in Directory of Stage

Advanced execution options

File transfer

- In the file transfer add a file copy action.
- As source file fill in the original .key file.
- As destination specify the file name DynaOpt.inp.
- Make sure that the “On Error” action is set to “fail”.



File Transfer

Files to be copied from the run directory of *PRIMER* to *LS-DYNA*:

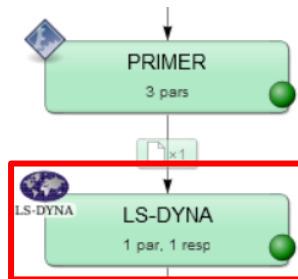
Operation	Source File	Destination File (wildcard ok)	On Error	Delete
Copy	tube.key	DynaOpt.inp (default is tube.key)	fail	✗

[Add ...](#)

OK

LS-DYNA stage

- In the LS-DYNA stage fill in the LS-DYNA executable path.
- As input file specify your .key file without directory path.
- Set the text box to copy the .key file to DynaOpt.inp in each run directory.



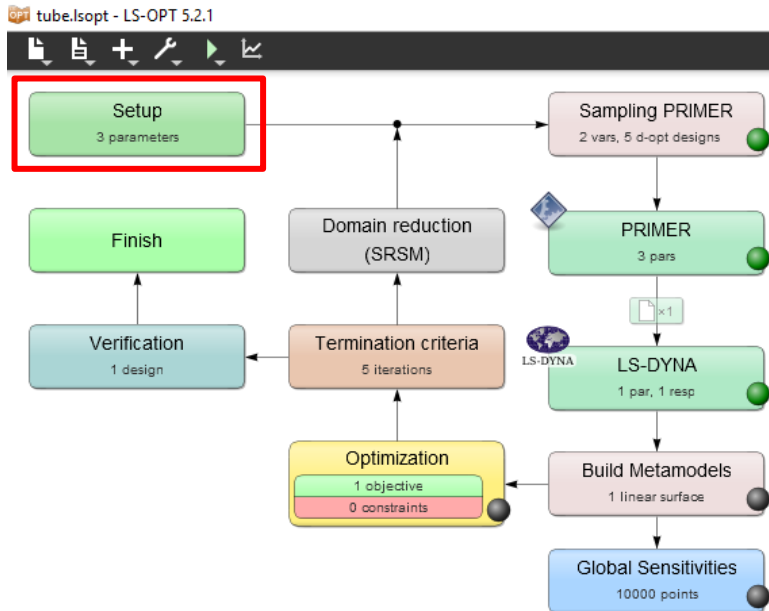
The screenshot shows the 'Stage LS-DYNA' configuration window with the following details:

- General**
 - Package Name: LS-DYNA
 - Command: C:\LSDYNA\EXE\R10\smg_single\ls-dyna_smp_s_R101_winx64_ifort131.exe
 - Input File: tube.key
 - Additional configuration: *copies tube.key (0 includes) to LS-DYNA/it.run/ DynaOpt.inp and substitutes parameters*
 - Extra input files: ☐
 - LS-DYNA Advanced Options button
- Execution**
 - Resources table:

Resource	Units per job	Global limit	Delete
LSDYNA	1	1	x
 - Advanced execution options:
 - ☐ Use Queuing
 - ☐ Use LSTCVM proxy
 - ☐ Environment Variables
 - ☐ Run Jobs in Directory of Stage
 - Advanced execution options button

Future LS-OPT versions

- In future versions it will also be possible to specify PRIMER directly in LS-OPT in the pre-processor stage definition. This will make the setup of the PRIMER command easier, and on Windows the run.bat files will no longer need to be created manually.
- The variable range information might be picked up automatically by the LS-OPT Setup stage from the JSON files.



Problem global setup

Parameter Setup Stage Matrix Sampling Matrix Resources Features

☐ Show advanced options

Type	Name	Starting	Minimum	Maximum	Delete
Constant	THICK	1.5			
Continuous	depth_x	0	-20	40	
Continuous	depth_y	0	-20	40	

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