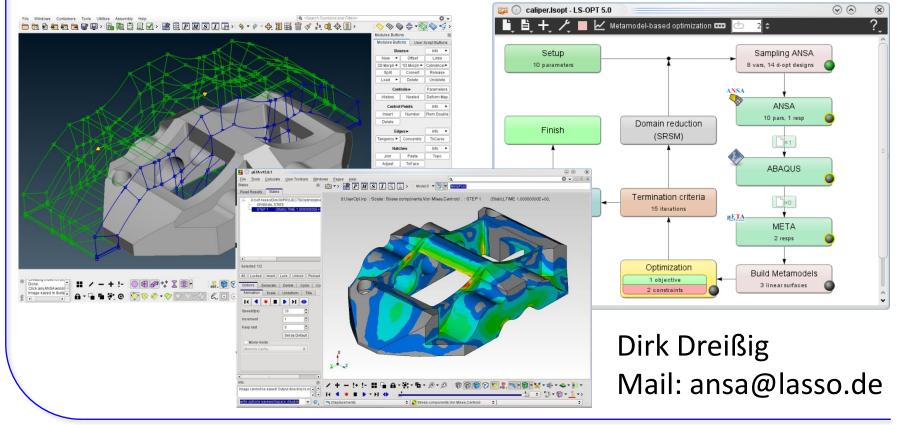


## Coupling ANSA and META to LS-OPT



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Optimization with ANSA, LS-OPT and META



## For what **ANSA** & **META**?

- ANSA for model/shape change according to design variables (parameters in text files can be handled directly from LS-OPT)
- META for results extraction of arbitrary solvers (LS-DYNA results or text files can be handled directly)

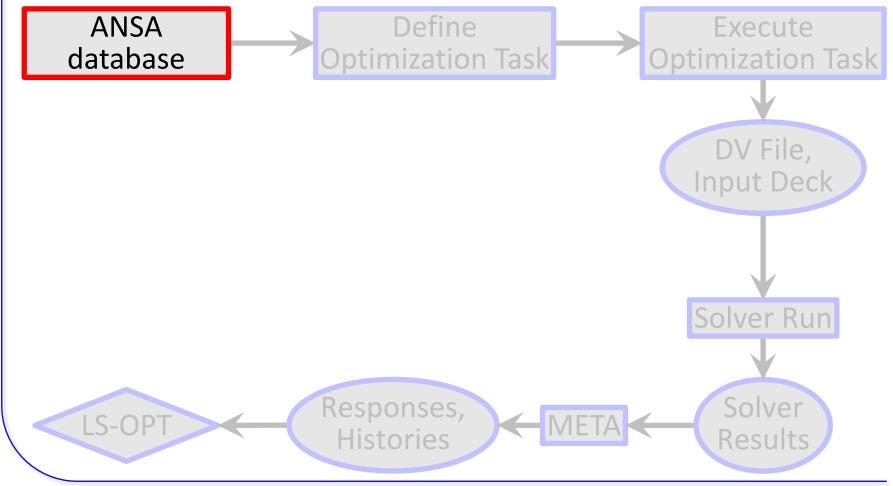
### <u>Setup phase</u>

- design variables defined in **ANSA**  $\rightarrow$  transfer to **LS-OPT**
- − histories and responses defined in META → transfer to
   LS-OPT
- Optimization (Run) phase
  - design variables controlled by **LS-OPT**  $\rightarrow$  transfer to **ANSA**
  - histories and responses calculated by META → transfer to
     LS-OPT



## **Optimization Setup**

#### **ANSA** $\rightarrow$ Solver $\rightarrow$ META $\rightarrow$ LS-OPT

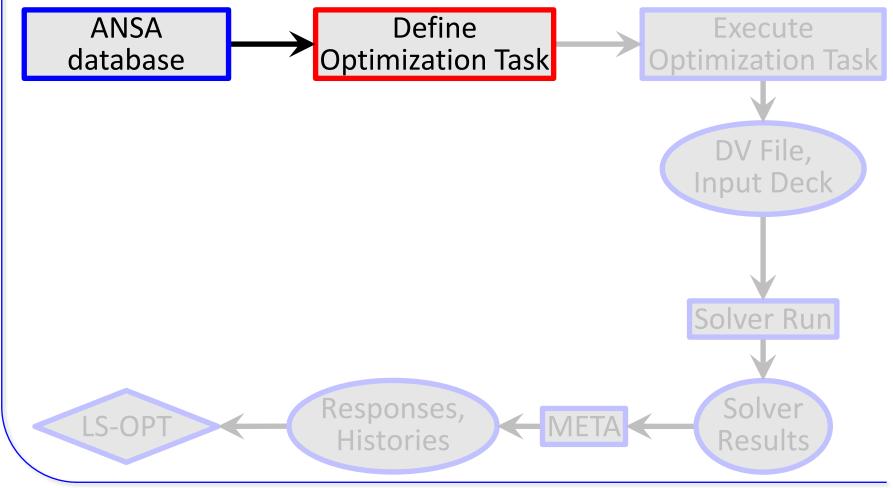


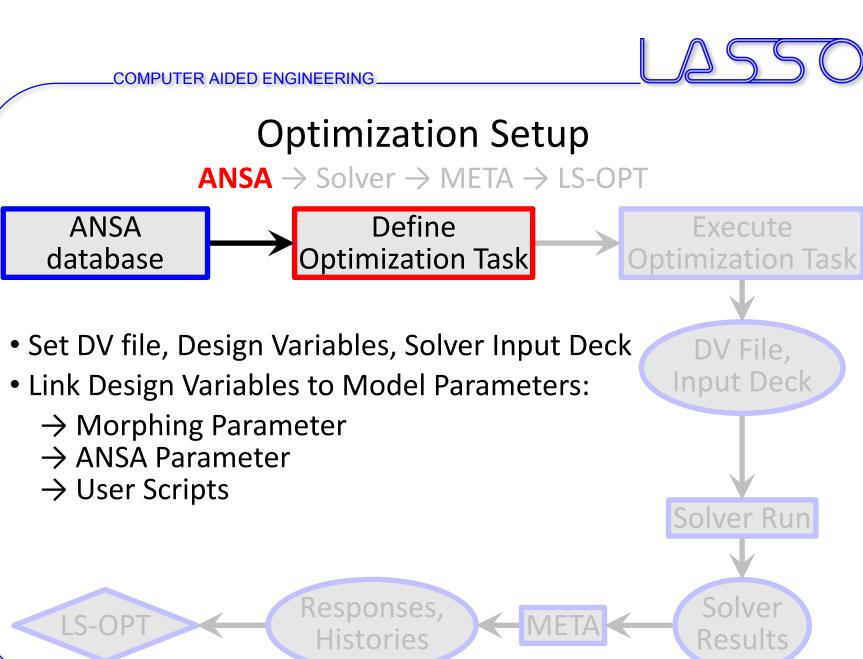
Copyright 2021, LASSO Ingenieurgesellschaft mbH All rights reserved Optimization with ANSA, LS-OPT and META



## **Optimization Setup**

#### $\textbf{ANSA} \rightarrow \textbf{Solver} \rightarrow \textbf{META} \rightarrow \textbf{LS-OPT}$

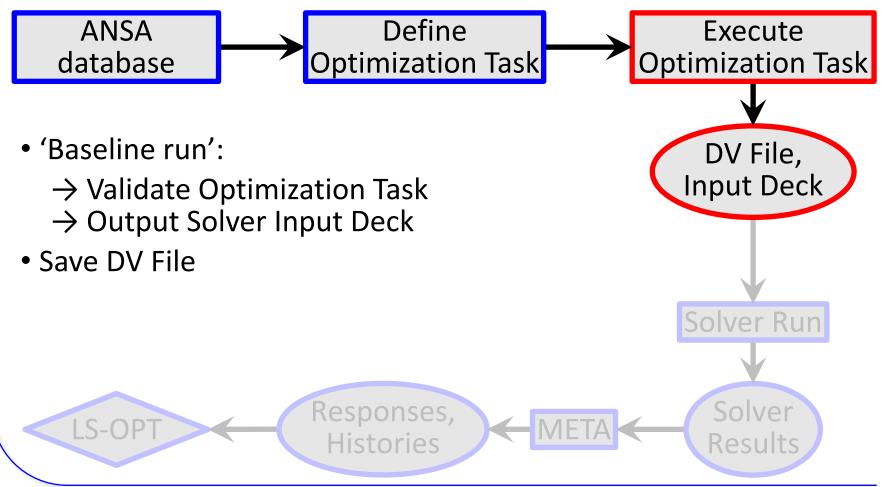






## **Optimization Setup**

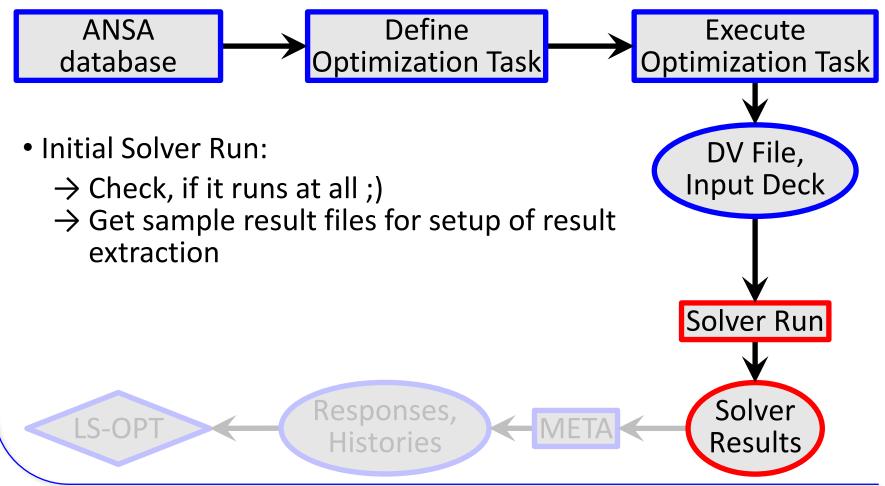
 $\textbf{ANSA} \rightarrow \textbf{Solver} \rightarrow \textbf{META} \rightarrow \textbf{LS-OPT}$ 

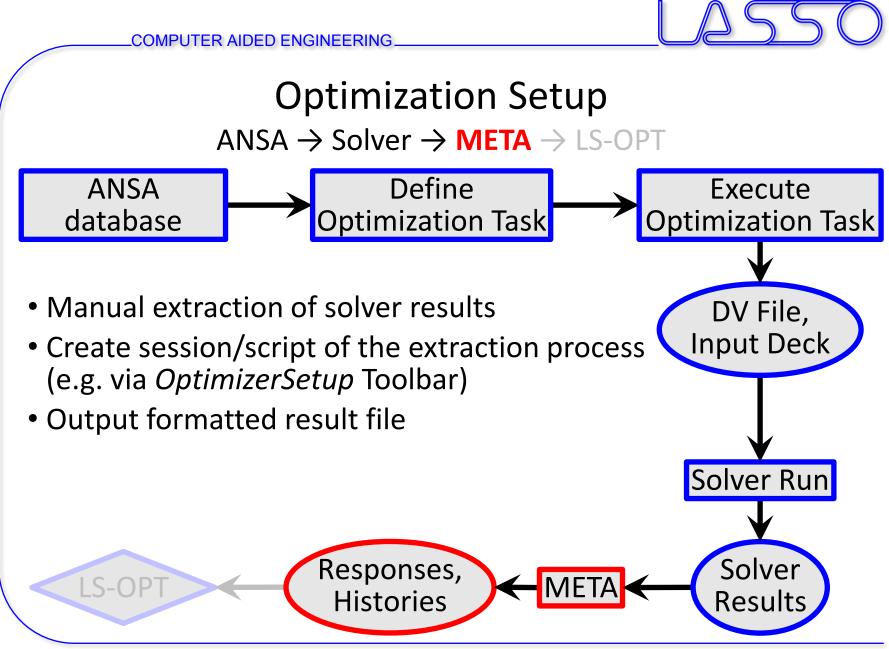


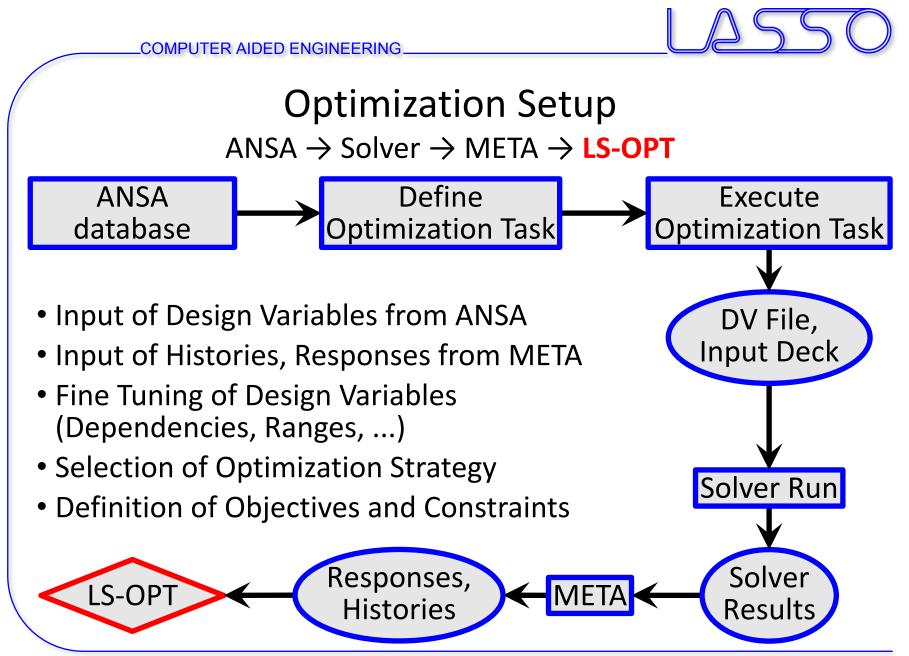


## **Optimization Setup**

 $\mathsf{ANSA} \rightarrow \mathbf{Solver} \rightarrow \mathsf{META} \rightarrow \mathsf{LS-OPT}$ 



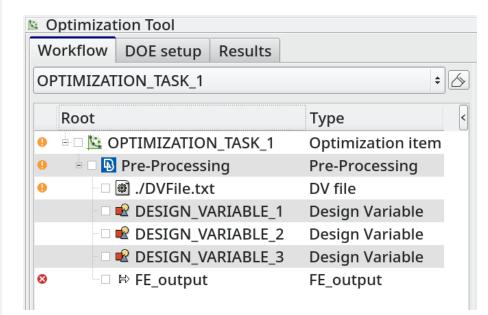




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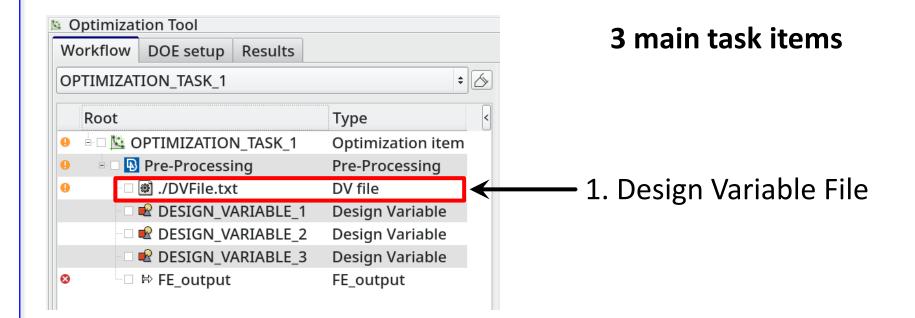
Optimization with ANSA, LS-OPT and META



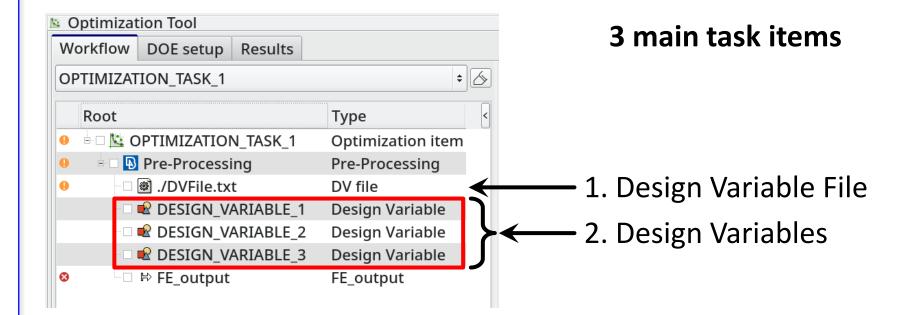


#### 3 main task items

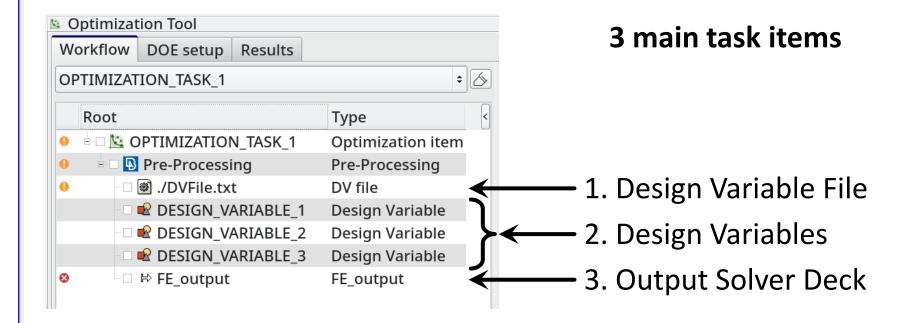














### ANSA – Optimization Task Design Variable File

Optimizat	ion Tool			
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	ail_crash_tm		FE_output	

ſ	#
1	# ANSA_VERSION: 14.2.3
I	#
I	# file created by A N S A Mon Feb 17 17:13:25 2014
I	#
J	# Output from:
1	# /odl/lasso/Dirk30/PR0JECTS/Optimierung_Rail_LS-OPT/Rail_MD0/rail_crash.ansa
I	#
I	# DESIGN VARIABLES
I	
I	# ID   DESIGN VARIABLE NAME   TYPE   RANGE   CURRENT VALUE   MIN VALUE> MAX VALUE   STEP #
I	# 10, rail_width, REAL, BOUNDS, 10., -20., 20.
I	10, Failwight BEAL BOUNDS, 10, -20, 20
I	11, rail_height, REAL, BOUNDS, 10., -20., 20. 1, embosses_depth, REAL, BOUNDS, 7., 0., 7.
I	3, embosses_width, REAL, BOUNDS, 10, -10, 10.
I	2, embosses pos, REAL, BOUNDS, -15., -50., 20.
I	7, embosses distance, REAL, BOUNDS, -15., -15., 50.
I	4, thickness_rail_plate, REAL, STEP, 1.5, 0.5, 2., 0.1
I	5, thickness_rail_profile, REAL, STEP, 1.5, 0.5, 2., 0.1
I	8, thickness_rail_flange, REAL, STEP, 1.5, 0.5, 3., 0.1
I	6, cnctn_spotline_dist, REAL, BOUNDS, 50., 20., 100.
1	9, cnctn_spotline_diam, REAL, STEP, 5., 2., 10., 1.
1	12, cnctn_spotpoint_diam, REAL, STEP, 5., 2., 10., 1.
L	#

#### Correctly formatted for import in LS-OPT



### ANSA – Optimization Task Design Variables → Morphing Parameters

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<b> - - - - - - - -</b>	rail_crash_tmp	o.key	FE_output

DESIGN VARIABL	E [DESIGN_VARIABLE]		
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embosses_width			
ОК			Cancel



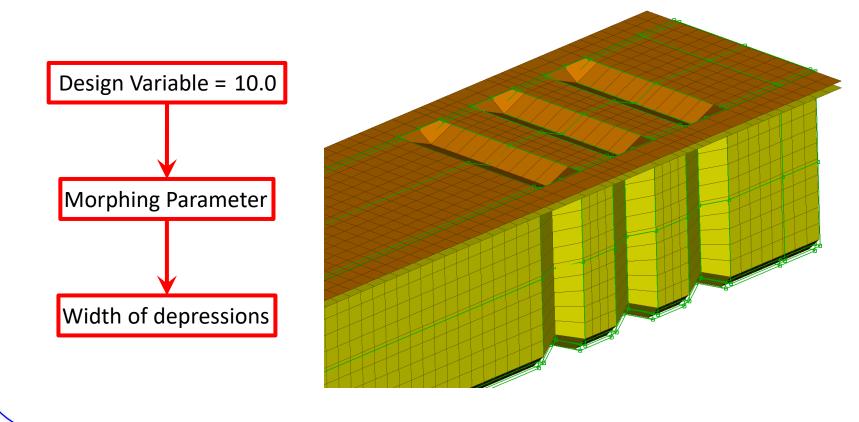
### ANSA – Optimization Task Design Variables → Morphing Parameters

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🖲 🖻 📽 embosses_distance	Design Variabl			Select param	eter to assig	n	
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😐 🗆 🗣 cnctn_spotline_diam	Design Variabl					embosses depth	
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- Apply_GEB_ORs	User Script			16 embos	ses_pos	embosses_pos	
口 III rail_crash_tmp.key	FE_output			17 embos	s12_distance	embosses_distance	



### ANSA – Optimization Task Design Variables $\rightarrow$ Morphing Parameters

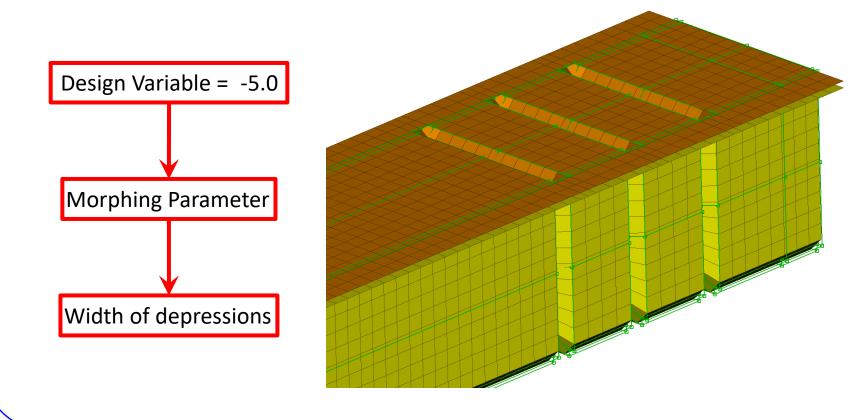
Shape modification





### ANSA – Optimization Task Design Variables $\rightarrow$ Morphing Parameters

Shape modification





### ANSA – Optimization Task Design Variables → ANSA Parameters

Optimizat	tion Tool		
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OPTIMIZAT	TON_TASK_1		\$
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- 🗆 🎩 F	Reconstruct_F	Rail	User Script
- B S	SMOOTH		Session Comm
- 🗆 🗐 A	Apply_GEB_OI	٦s	User Script
- 🗆 🖙 r	ail_crash_tm	p.key	FE_output

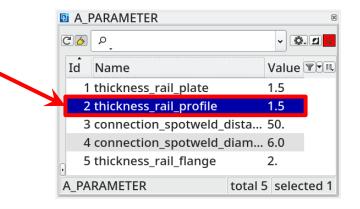
DESIGN VARIABL	_E [DESIGN_VARIABLE]		×
Name thickness_	rail_profile		
ID 5 Min Value 0.5 Comment	TYPE REAL · Current Value 1.5	RANGE STEP - Max Value 2.	Step Value
thickness_rail_pro	ofile		
ОК			Cancel



### ANSA – Optimization Task Design Variables → ANSA Parameters

🖻 Optimizat	tion Tool		
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	Apply_GEB_OF		User Script
	rail_crash_tmp	o.key	FE_output

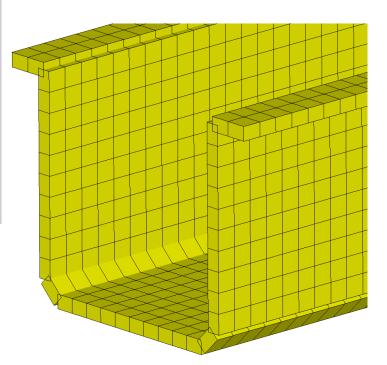
DESIGN VARIAE	BLE [DESIGN_VARIABLE]		(3
Name <mark>thickness</mark>	_rail_profile		
ID	ТҮРЕ	RANGE	
5	REAL -	STEP -	
Min Value	Current Value	Max Value	Step Value
0.5	1.5	2.	0.1
Comment			
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thickness_rail_p	rofile		
ОК			Cancel
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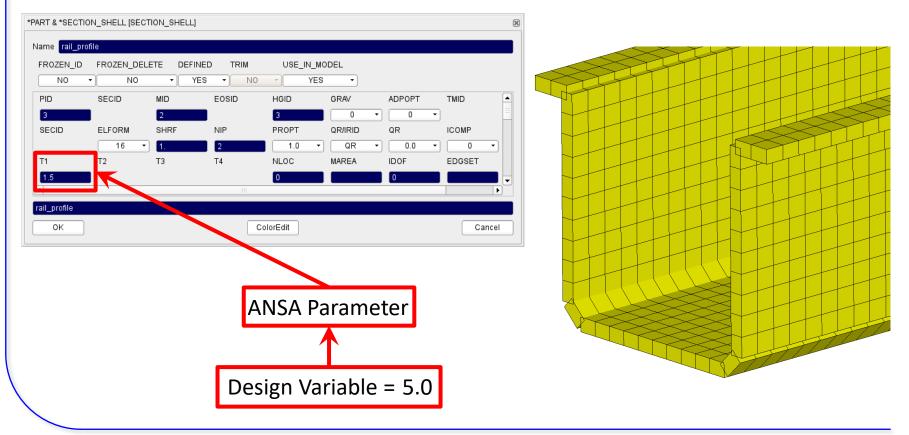
### Modification of **shell thicknesses**, materials, etc.

ART & *SECTI	ON_SHELL [SEC	TION_SHELL]						
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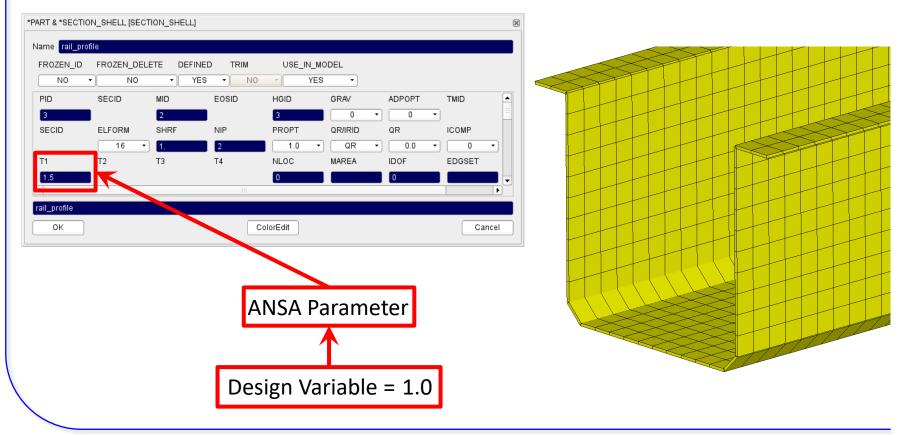


### Modification of shell thicknesses, materials, etc.





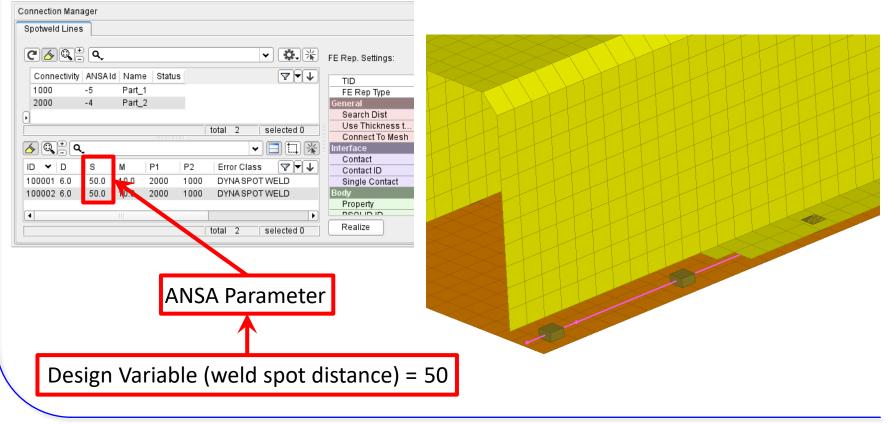
### Modification of **shell thicknesses**, materials, etc.



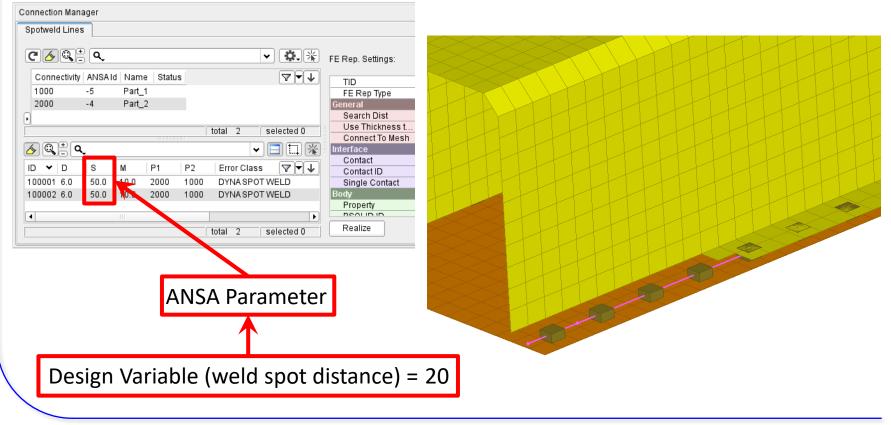


Spotweld Lines   Connectivity ANSAId Name Status  Connectivity ANSAId Name Status  TID  FE Rep Type  General  Search Dist Use Thickness t			
Connectivity     ANSAId     Name     Status       1000     -5     Part_1       2000     -4     Part_2			
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1000         -5         Part_1         FE Rep Type           2000         -4         Part_2         General           Search Dist         Search Dist         Search Dist			
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100002 6.0 50.0 10.0 2000 1000 DYNA SPOT WELD Body		+ I I	
Property			
total 2 selected 0 Realize			





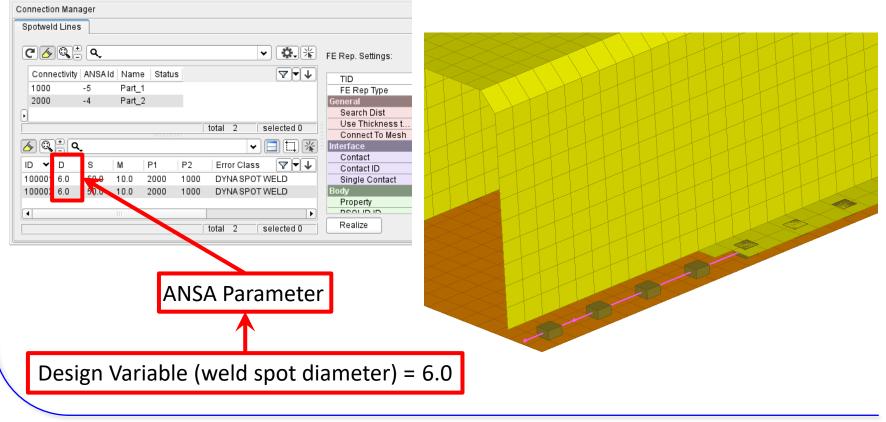




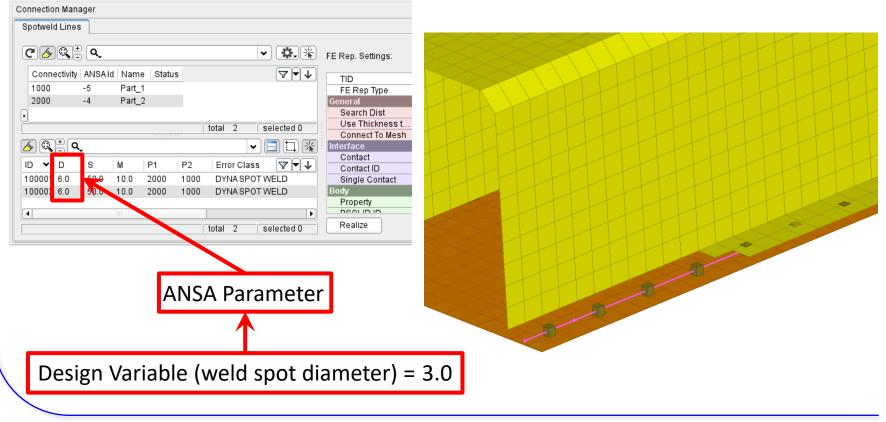


Manager	
Lines	
Contraction of the settings:	
ctivity ANSAId Name Status	
-5 Part_1 FE Rep Type	
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D S M P1 P2 Error Class V Contact Contact D	
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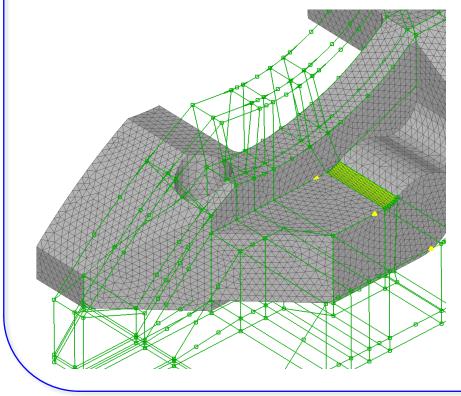






## ANSA – Optimization Task DOE $\rightarrow$ Simulate

- Checking DV combinations (e.g. Full Factorial) → Model Validity
- Checking Element Criteria

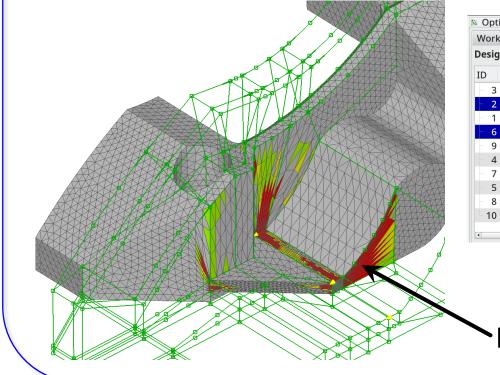


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- 2	2 DV_Br	eite_Seitenst	eg	0	10.	2	2.	5.
- 1	DV_Br	eite_Flachste	eg_oben	0.	20.	3	4.	10.
- 6	5 DV_Br	eite_Flachste	eg_unten	0.	25.	4	6.	15.
9	DV_H	oehe_Nase		0.	10.	5	8.	20.
4	LDV_Br	eite_Mittelst	eg_ob_au	-20.	13.	6	10.	25.
- 7	7 DV_Br	eite_Mittelst	eg_ob_in	-20.	13.			
5	5 DV_Br	eite_Mittelst	eg_un_au	-13.	10.			
8	B DV_Br	eite_Mittelst	eg_un_in	-13.	10.			
10	DV_Br	eite_Nase		0.	20.			



## ANSA – Optimization Task DOE $\rightarrow$ Simulate

- Checking DV combinations (e.g. Full Factorial) → Model Validity
- Checking Element Criteria



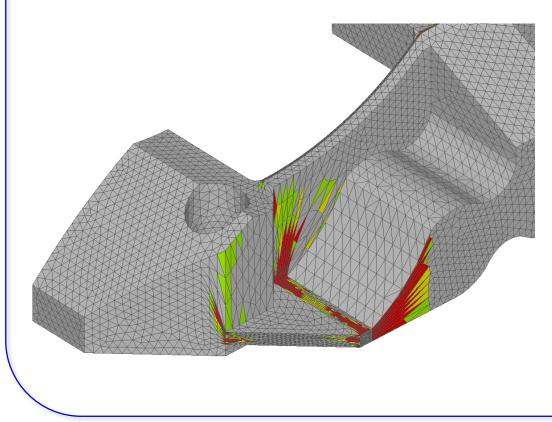
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**`Failed elements** 



## ANSA – Optimization Task User Scripts / User Actions

#### For improving mesh quality

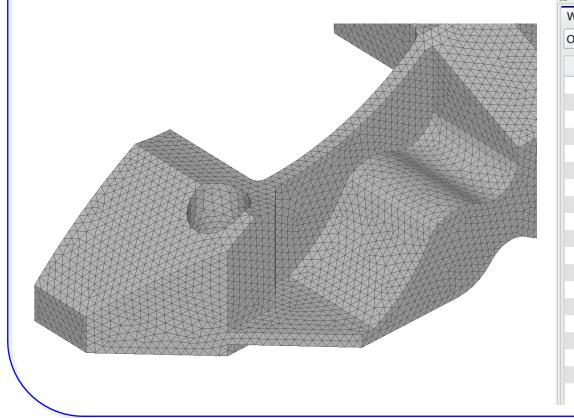


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	🗐 CreateVolu		leshIt	
	🗐 Renumber	All		
	CalcMass			
[] ;	💠 BrakeCalip	per_tmp.ir	пр	



## ANSA – Optimization Task User Scripts / User Actions

#### For improving mesh quality

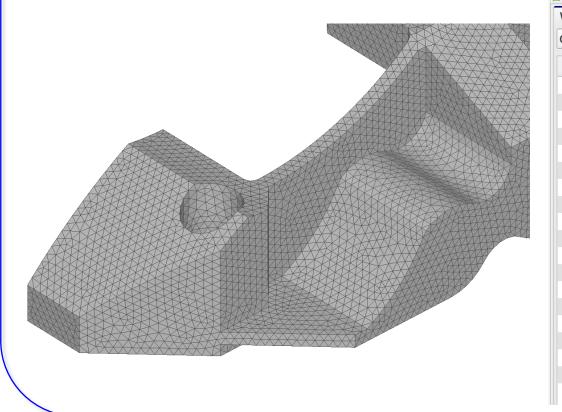


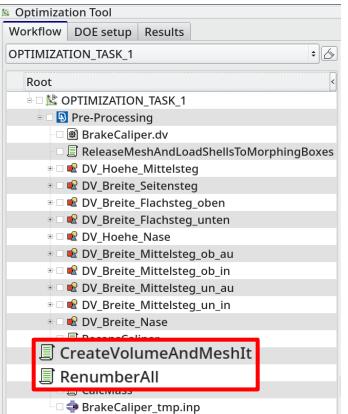
Optimizat	tion Tool				
Vorkflow	DOE setup	Results			
OPTIMIZAT	TION_TASK_1				\$
Root					<
🖶 🗆 🔛 C	OPTIMIZATIO	N_TASK_			
	Pre-Processi				
	🖲 BrakeCalip	per.dv			
	🗐 ReleaseMe	eshAndL	oadShellsTo	Morphingl	Boxes
	🖻 DV_Hoehe				
<b>.</b>	🖻 DV_Breite	Seitenst	eg		
•••	🖻 DV_Breite	Flachste	g_oben		
•	🖻 DV_Breite	Flachste	g_unten		
•••	🗣 DV_Hoehe	_Nase			
•	🗣 DV_Breite	Mittelst	eg_ob_au		
•••	🗣 DV_Breite_	Mittelst	eg_ob_in		_
<b>.</b>	🗣 DV_Breite_	Mittelst	eg_un_au		
Đ · 🗌	DV_Breite	Mittelst	eg_un_in		
	🕞 DV Breite				
	ReconsCa				
	🗐 Createvoii	umeAnd	VleshIt		
	🗐 Renumber	All			
	🗐 CalcMass				
L	💠 BrakeCalip	per_tmp.	inp		



## ANSA – Optimization Task User Scripts / User Actions

#### For creating Volume Mesh, Renumber, ...







### ANSA – Optimization Task Responses

## From card values or measurements (e.g. mass, distances after morphing)

Workflow DOE setup Results						
OPTIMIZATION_TASK_1	÷ 🖉	Des	ign variables			
Root		ID	Name	TYPE	RANGE	
B 🖸 🔛 OPTIMIZATION_TASK_1			1 front_height	REAL	BOUNDS	5
Pre-Processing			2 side_height	REAL	BOUNDS	5
DVFile.txt			3 side_width	REAL	BOUNDS	5
• iți front height			4 rear_height	REAL	BOUNDS	5
e 🗌 🕂 ili side_height			5 rear_width	REAL	BOUNDS	5
• iti side width			6 PSHELL_700001_T	_1 REAL	LIST	
ili side_main			7 PSHELL_700002_T	_1 REAL	LIST	
• _ †‡i rear width			8 PSHELL_700005_T	_1 REAL	LIST	
			9 PSHELL_700006_T	_1 REAL	LIST	
● □ 前 PSHELL 700002 T 1			10 PSHELL_700007_T	_1 REAL	LIST	
● □ țłi PSHELL 700005 T 1						
=		Resp	oonses Ansa & Meta			
		Id	Name Value			
biw_execute.nas			No "Respons	es" task it	em found	1!
Solver						
			ANSA measurements			ta
			d lliw	e listed h	ere	_
		Con	straints			
		Nan	ne Expression Opera	tor Limit		
Baseline run						



## ANSA – Optimization Task Responses

## From card values or measurements (e.g. mass, distances after morphing)

Workflow DOE setup Results									
OPTIMIZATION_TASK_1			÷ 🛆	> De	si	gn variables			
Root		Ţ		> ID	)	Name	TYPE	RANGE	(
🛛 🗌 🔽 OPTIMIZATION_TA	SK 1					1 front_height	REAL	BOUND	S
Pre-Processing						2 side heiaht	REAL	BOUND	S
DVFile.txt		New El Video				Design Variables	REAL	REAL BOUND	
🖲 🗌 👬 front_height	Ð					Responses	REAL	REAL BOUNDS	
🖲 🗌 👬 side_height	Ť	Delete				Report	REAL		S
• 🗌 †‡† side_width		▶ Run				FE output		REAL LIST	
🖷 🗌 ṫłṫ rear_height	-				_	Reapply Connections		LIST	
• 🗆 †‡† rear_width		Cut		Ctrl+X		Response Item	REAL	LIST	
	1_T_	Сору	(	Ctrl+C		Visibility control		LIST	
● □ 前前 PSHELL_70000     □	2_T_	Paste	te Ctr			, , , , , , , , , , , , , , , , , , ,	REAL	LIST	
🖲 🗋 †‡† PSHELL_70000	5_T_	view		1	•	Check Template User Script			
• 🗆 †‡† PSHELL_70000					-				
• 🗌 †計 PSHELL_70000	/_!_					User Scripts			
biw_execute.na	as					Session Command Reminder		ask item found! n "Responses" ta :ed here	
Solver									
		Set Icon			_	Template items			
				Со	n	User Actions	•		
				Na	am	e Expression Operato	r Limit		
▶ Baseline run									



#### ANSA – Optimization Task Responses

# From card values or measurements (e.g. mass, distances after morphing)

Workflow DOE setup Results					
OPTIMIZATION_TASK_1	* 🖉	Desig	gn variables		
Root		ID	Name	TYPE	RANGE
B 🗌 🗏 OPTIMIZATION_TASK_1			1 front_height	REAL	BOUND
Pre-Processing			2 side_height	REAL	BOUND
DVFile.txt			3 side_width	REAL	BOUND
● □ 討 front_height			4 rear_height	REAL	BOUND
● □ 計 side_height			5 rear_width	REAL	BOUND
ال ألبة side width			6 PSHELL_700001_1		
e 🗌 ili rear height			7 PSHELL_700002_1	1 REAL	LIST
			8 PSHELL_700005_1		
			9 PSHELL_700006_1		
● □ †#† PSHELL_700002_T1		1	0 PSHELL_700007_1	[_1 REAL	LIST
● 🗌  PSHELL_700005_T1					
		Resp	onses Ansa & Meta		
		Id	Name		Value
MEASUREMENT_1_RESU	JLT	-1	MEASUREMENT_1	_RESULT	72.6283
MEASUREMENT_2_RESU	JLT	2	MEASUREMENT_2	2_RESULT	0.0025
📄 🕃 Responses.txt					
biw_execute.nas		•		III	
88 Solver		Cons	traints		
		Nam	e Expression Opera	ator Limit	
Baseline run					



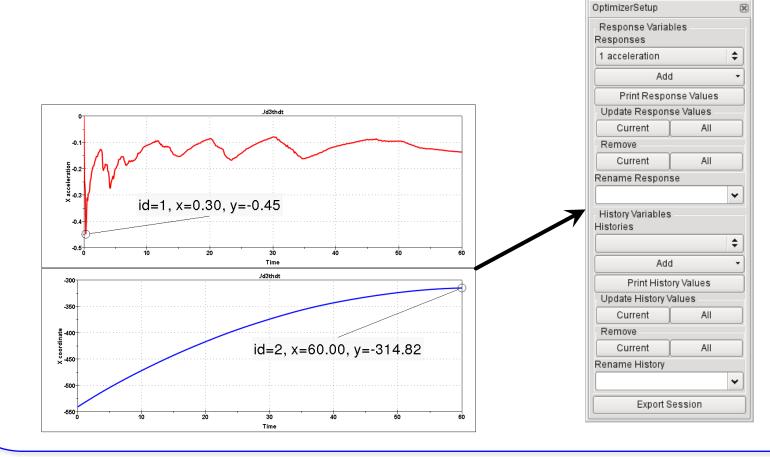
#### ANSA – Optimization Task Responses

# From card values or measurements (e.g. mass, distances after morphing)

PPTIMIZATION_TASK_1 <ul> <li>Design variables</li> <li>D Name</li> <li>TYPE RANGE C</li> <li>1 front_height</li> <li>Real BOUNDS</li> <li>2 side_height</li> <li>Real BOUNDS</li> <li>3 side_width</li> <li>Real BOUNDS</li> <li>5 rear_width</li> <li>Real BOUNDS</li> <li>6 PSHELL_700001_T_1 REAL LIST</li> <li>9 PSHELL_700005_T_1 REAL LIST</li> <li>9 PSHELL_700005_T_1 REAL LIST</li> <li>9 PSHELL_700005_T_1 REAL LIST</li> <li>10 PSHELL_700005_T_1 REAL LIST</li> <li>9 PSHELL_70005_T_1 REAL LIST</li> <li>9 PSHELL_700005_T_1</li></ul>	Baseline run	Constraints Name Expression Opera	tor Limit	:	Correctly formatted for import in LS-OPT
Root       IF TYPE RANGE C         Image: Control of the system of the syste			III		2 , MEASUREMENT_2_RESULT, 0.00254558727831932 #
Root       Image of the second s		2 MEASUREMENT_2	_RESULT	0.0025	
Root   Image: Description of the state of			RESULT		#
Root   ID   Name   TYPE   RANGE   ID    ID		•		Value	#
Root   ID   Name   TYPE   RANGE   Pre-Processing   Pre-Processing   DVFile.txt   BDVFile.txt   BDVFile.txt <		Pernonses Ansa & Meta			# RESPONSES
Root   ID   Name   TYPE   RANGE   C   Pre-Processing   DVFile.txt   DVFile.txt   If front_height   If front_height   If if side_height   If if rear_height   If if rear_height   If if rear_width   If if PSHELL_700001 T_1     PSHELL_700006 T_1 REAL		10 PSHELL_700007_T	_1 REAL	LIST	
Root       II       Name       TYPE       RANGE	-				
Root       Image of the second s					
Root       Image of the state	_				
Root       Image of the state		-			
Root     ID     Name     TYPE     RANGE       Image: Strain					
Root     ID     Name     TYPE     RANGE     C            · · · · · · · · · · · · · · ·		-			
Root     ID     Name     TYPE     RANGE       I     1     frant     birbt     DEAL     DOUNDS		= 5			
	PTIMIZATION_TASK_1		7.00	DANGE O	



### META – OptimizerSetup Toolbar



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X

\$

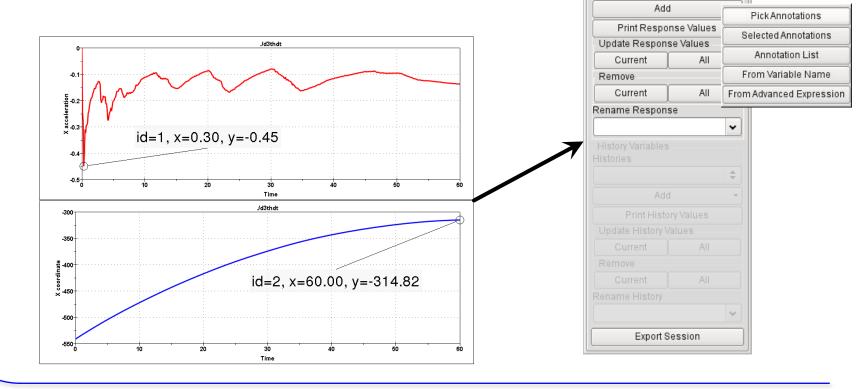
OptimizerSetup

1 acceleration

Response Variables Responses

### META – OptimizerSetup Toolbar

• Responses from annotations, variables, advanced expressions



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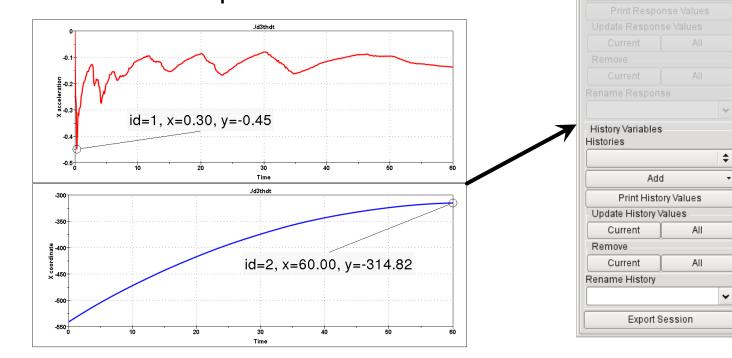


X

OptimizerSetup

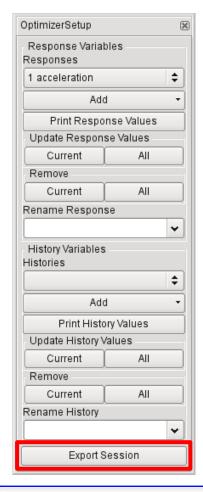
## META – OptimizerSetup Toolbar

- Responses from annotations, variables, advanced expressions
- Histories from 2D plot curves





# META – OptimizerSetup Toolbar



#### Exports:

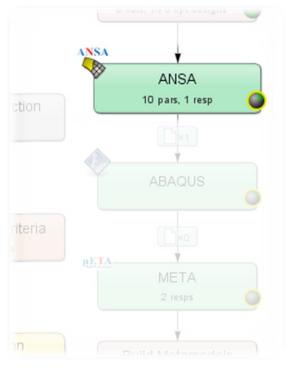
- Session file (for reproduction of results extraction)
- Output file, containing responses and histories

```
#OptimizerSetup Response & history File created by META post
RESPONSES
1,acceleration,-1.18
2,intrusion,-440.07
END
```

#### Correctly formatted for import in LS-OPT



#### Stage for ANSA



🖬 🕐 Stage I	ANSA			$\odot$
Setup Pa	rameters Histories	Responses File Ope	rations	
General				
Package Nan	ne ANSA			~
Command	ansa -Im_retry 10 - gui /	ANSA_D30		Browse
	Do not add input file	argument		
DV File	BrakeCaliper.dv			Browse
	copies BrakeCaliper.dv and substitutes parame	(0 includes) to ANSA/it.1 ters	run/ANSAOpt.inp	
	Extra input files			
Model Databa	se BrakeCaliper.ansa			Browse
Executio		Units per job	Global limit	Browse
Executio Resources		Units per job	Global limit	
Executio Resources Resource	on			Delete
Executio Resources Resource ANSA	esource			Delete
Executio Resources Resource ANSA Create new re	esource			Delete
Executic Resource ANSA Create new m Use Queu Use LSTC Environm	esource ling SVM proxy ent Variables			Delete
Executic Resource ANSA Create new m Use Queu Use LSTC Environm	esource ling SVM proxy			Delete
Executio Resources Resource ANSA Create new ro Use Queu Use LSTO Environm	esource ling SVM proxy ent Variables			Delete



#### $\mathsf{ANSA} \rightarrow \mathsf{DV}$ file $\rightarrow$ Design Variables in LS-OPT

NSA_VERSION: 15.0.1	Parameter Set	up Stage Matrix	Sampling M	atrix R	esources	Features	
ile created by A N S A Fri Feb 14 15:49:00 2014	🖌 Show advan	ced options					
utput from: nsaout.ansa	Туре	Name		Starting	Init. Range	Minimum	Maximun
DESIGN VARIABLES	Continuous 🗸	DV_Breite_Flachst	eg_oben )	0		0	1
D   DESIGN VARIABLE NAME   TYPE   RANGE   CURRENT V/	Continuous 🗸	DV_Breite_Flachst	eg_unten	0		0	2
DV Hoehe Mittelsteg, REAL, BOUNDS, 0., -5.	Continuous 🗸	DV_Breite_Mittelst	eg_ob_au )(	0		0	1
Breite Flachsteg oben, REAL, BOUNDS, 0., -5 Breite Flachsteg oben, REAL, BOUNDS, 0.	Continuous 🗸	DV_Breite_Mittelst	eg_ob_in )(	10		-20	1
_Breite_Flachsteg_unten, REAL, BOUNDS, ( / Hoehe Nase, REAL, BOUNDS, 0., 0., 10.	Continuous 🗸	DV_Breite_Mittelst	eg_un_au )(	0		0	1
Breite_Mittelsteg_ob_au, REAL, BOUNDS, Breite_Mittelsteg_ob_in, REAL, BOUNDS,	Continuous 🗸	DV_Breite_Mittelst	eg_un_in )(	5		-13	1
Breite_Mittelsteg_un_au, REAL, BOUNDS, Breite_Mittelsteg_un_au, REAL, BOUNDS, Breite Mittelsteg un in, REAL, BOUNDS,	Continuous 🗸	DV_Breite_Nase		0		0	2
_Breite_Nase, REAL, BOUNDS, 0., 0., 20.	Continuous 🗸	DV_Breite_Seitens	steg (	0		-5	1
	Continuous 🗸	DV_Hoehe_Mittels	teg (	0		-5	12
l	Continuous 🗸	DV_Hoehe_Nase		0		0	10
	<						
	Add						

.....



#### Fine Tuning of Design Variables, e.g.

Туре	Name	Starting	Init. Range	Minimum	Maximum
Continuous	<ul> <li>DV_Breite_Flachsteg_oben</li> </ul>	) 0	8	0	[ 18
Continuous •	<ul> <li>DV_Breite_Flachsteg_unten</li> </ul>	) 0	12	0	2
Continuous •	✓ DV_Breite_Mittelsteg_ob_au	0	6	0	1:
Dependent ·	✓ DV_Breite_Mittelsteg_ob_in	Definition:	DV_Breite_	Mittelsteg_c	b_au
Continuous ·	✓ DV_Breite_Mittelsteg_un_au	0	5	0	1
Dependent ·	✓ DV_Breite_Mittelsteg_un_in	Definition:	DV_Breite_	Mittelsteg_u	in_au
Continuous ·	✓ DV_Breite_Nase	0	10	0	2
Continuous	✓ DV_Breite_Seitensteg	0	8	-5	1
Continuous	✓ DV_Hoehe_Mittelsteg	0	8	-5	1:
Continuous	✓ DV_Hoehe_Nase	0	5	0	10
<					



#### Fine Tuning of Design Variables, e.g.

Ranges

Show adva	nced options				
Туре	Name	Starting	Init. Range	Minimum	Maximun
Continuous	<ul> <li>DV_Breite_Flachsteg_oben</li> </ul>	0	8	0	1
Continuous	<ul> <li>DV_Breite_Flachsteg_unten</li> </ul>	) 0	12	0	2
Continuous ·	✔ DV_Breite_Mittelsteg_ob_au	) 0	6	0	1
Dependent	<ul> <li>DV_Breite_Mittelsteg_ob_in</li> </ul>	Definition:	DV_Breite_	Mittelsteg_c	b_au
Continuous ·	✓ DV_Breite_Mittelsteg_un_au	0	5	0	1
Dependent	✓ DV_Breite_Mittelsteg_un_in	Definition:	DV_Breite_	Mittelsteg_u	in_au
Continuous	✓ DV_Breite_Nase	0	10	0	2
Continuous	<ul> <li>DV_Breite_Seitensteg</li> </ul>	0	8	-5	1
Continuous	✓ DV_Hoehe_Mittelsteg	0	8	-5	1
Continuous	✓ DV_Hoehe_Nase	0	5	0	1
<					



Fine Tuning of Design Variables, e.g.

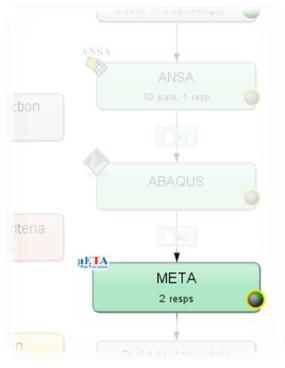
- Ranges
- Dependencies
- etc.

🗹 Show advar	nced options				
Туре	Name	Starting	Init. Range	Minimum	Maximun
Continuous	<ul> <li>DV_Breite_Flachsteg_oben</li> </ul>	) 0	8	0	1
Continuous	<ul> <li>DV_Breite_Flachsteg_unten</li> </ul>	0	12	0	2
Continuous	DV_Breite_Mittelsteg_ob_au	0	6	0	1
Dependent 🔹	DV_Breite_Mittelsteg_ob_in	Definition:	DV_Breite_	Mittelsteg_o	b_au
Continuous 🔹	DV_Breite_Mittelsteg_un_au	)( 0)	5	0	[ 1
Dependent 🔹	DV_Breite_Mittelsteg_un_in	Definition:	DV_Breite_	Mittelsteg_u	in_au
Continuous	DV_Breite_Nase	)( 0	10	0	2
Continuous	<ul> <li>DV_Breite_Seitensteg</li> </ul>	0	8	-5	1
Continuous	<ul> <li>DV_Hoehe_Mittelsteg</li> </ul>	0	8	-5	1
Continuous	DV_Hoehe_Nase	0	5	0	1
<					



### Connecting META to LS-OPT

#### Stage for META



🛛 🕐 Stage I	META			$\odot$
Setup Pa	rameters Histories R	esponses File Ope	rations	
General				
Package Nan				~
Command	meta - Im_retry 10			Browse
Session File	BrakeCaliperResults.ses			Browse
Output File	METAPost_results.txt			Browse
Database File	e ./			Browse
Resources	on			
Executio Resources Resource	on	Units per job	Global limit	Delete
Resources		Units per job	Global limit	Delete ×
Resource Resource METAPOST Create new r Use Queu Use LSTO Environm	esource			
Resource Resource METAPOST Create new r Use Queu Use LSTO Environm	esource Ling CVM proxy ent Variables . in Directory of Stage			



## Connecting META to LS-OPT

#### META $\rightarrow$ Output file $\rightarrow$ Responses and Histories in LS-OPT

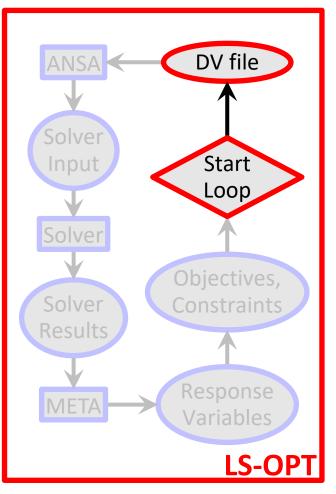
2,max_stress,169.780731 ND	Setup Parameters Histories Re	esponses File Operations
l	Response definitions	Add new
	max_stress	Generic
	POSTPRO: Result from METAPost	USERDEFINED
	nodes_rel_disp	GENEX
	POSTPRO: Result from METAPost	EXPRESSION
		FUNCTION
		INJURY
		MATRIX EXPRESSION



#### $\textbf{LS-OPT} \rightarrow \textbf{ANSA} \rightarrow \textbf{Solver} \rightarrow \textbf{META} \rightarrow \textbf{LS-OPT}$

# LS-OPT determines set of DV and outputs DV file

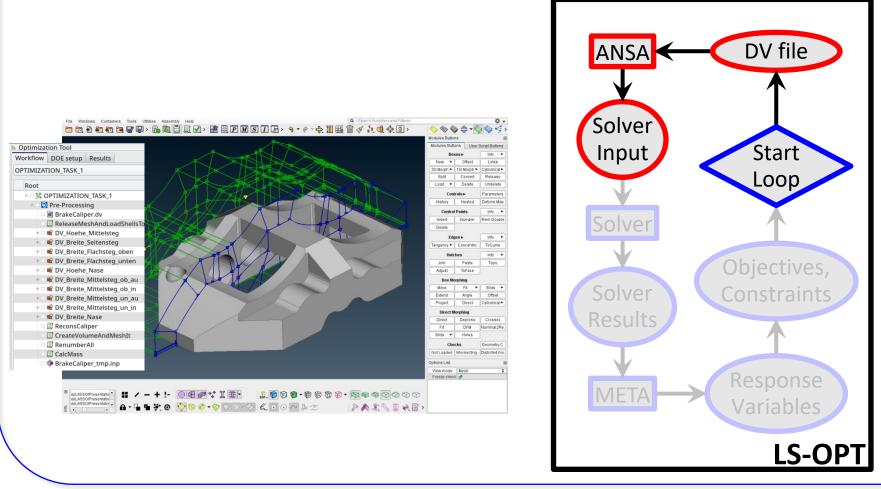
A	
# # IC	
#	)   DESIGN VARIABLE NAME   TYPE   RANGE   CURRENT VALUE   MIN VALUE



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#### $\mathsf{LS}\text{-}\mathsf{OPT} \to \mathsf{ANSA} \to \mathsf{Solver} \to \mathsf{META} \to \mathsf{LS}\text{-}\mathsf{OPT}$



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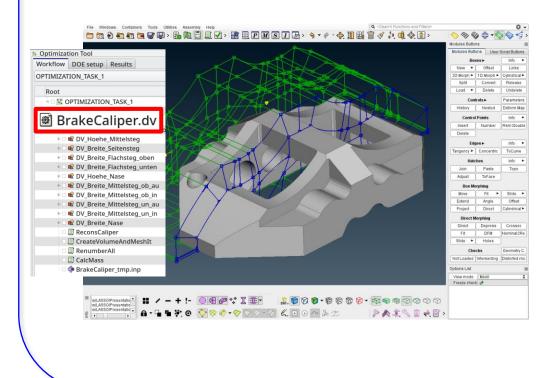


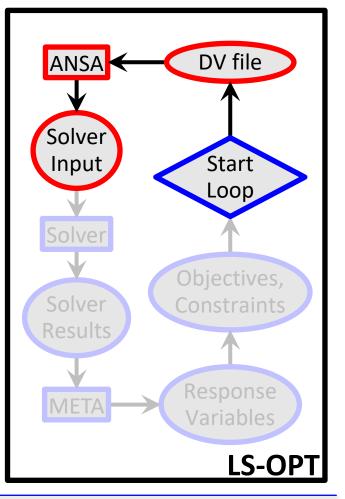
COMPUTER AIDED ENGINEERING.

## **Optimization Run**

#### $\mathsf{LS}\text{-}\mathsf{OPT} \xrightarrow{} \mathsf{ANSA} \xrightarrow{} \mathsf{Solver} \xrightarrow{} \mathsf{META} \xrightarrow{} \mathsf{LS}\text{-}\mathsf{OPT}$

• ANSA reads DV from DV file



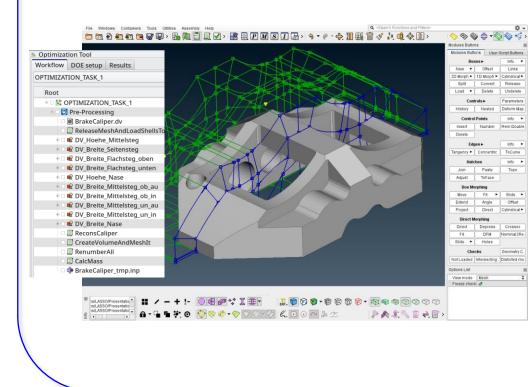


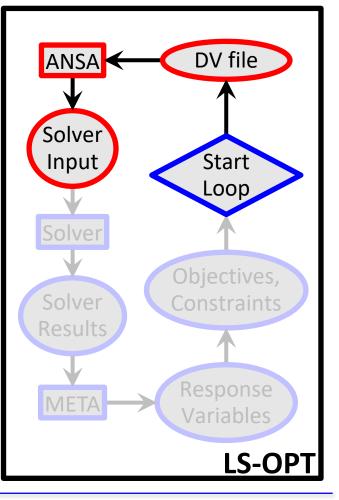
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#### $\mathsf{LS}\text{-}\mathsf{OPT} \xrightarrow{} \mathsf{ANSA} \xrightarrow{} \mathsf{Solver} \xrightarrow{} \mathsf{META} \xrightarrow{} \mathsf{LS}\text{-}\mathsf{OPT}$

- ANSA reads DV from DV file
- executes Optimization Task sequence

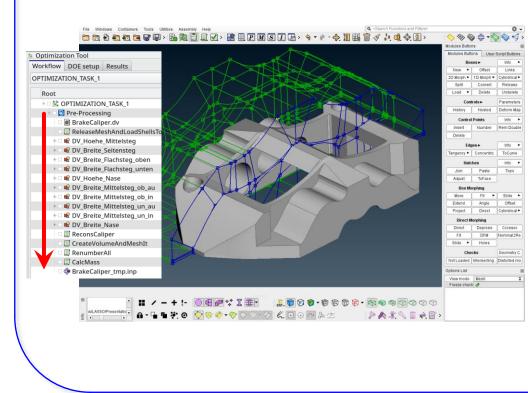


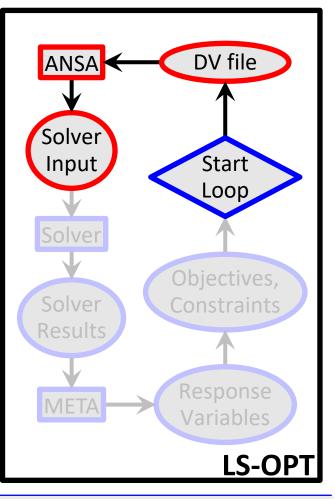




#### $\mathsf{LS}\text{-}\mathsf{OPT} \xrightarrow{} \mathsf{ANSA} \xrightarrow{} \mathsf{Solver} \xrightarrow{} \mathsf{META} \xrightarrow{} \mathsf{LS}\text{-}\mathsf{OPT}$

- ANSA reads DV from DV file
- executes Optimization Task sequence

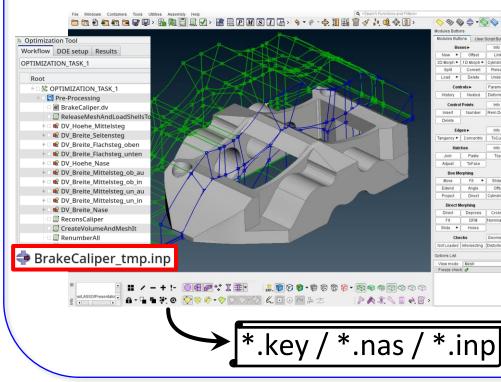


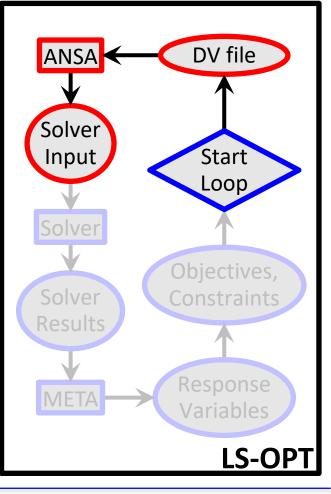


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#### $\mathsf{LS}\text{-}\mathsf{OPT} \xrightarrow{} \mathsf{ANSA} \xrightarrow{} \mathsf{Solver} \xrightarrow{} \mathsf{META} \xrightarrow{} \mathsf{LS}\text{-}\mathsf{OPT}$

- ANSA reads DV from DV file
- executes Optimization Task sequence
- outputs solver input deck

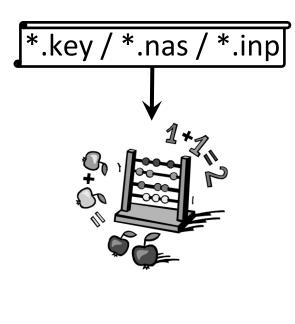


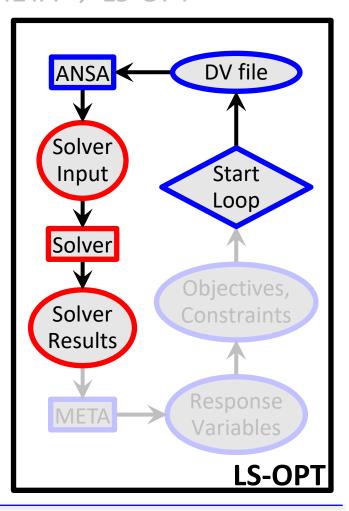


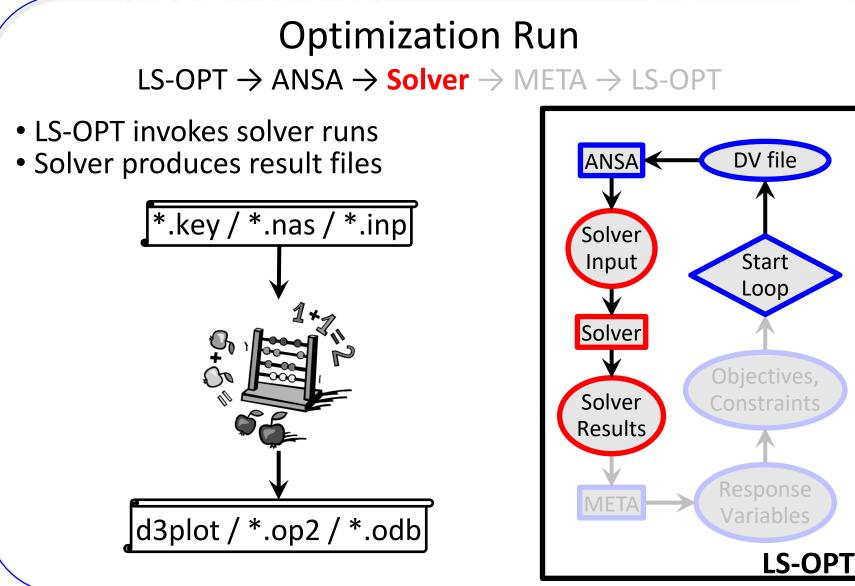
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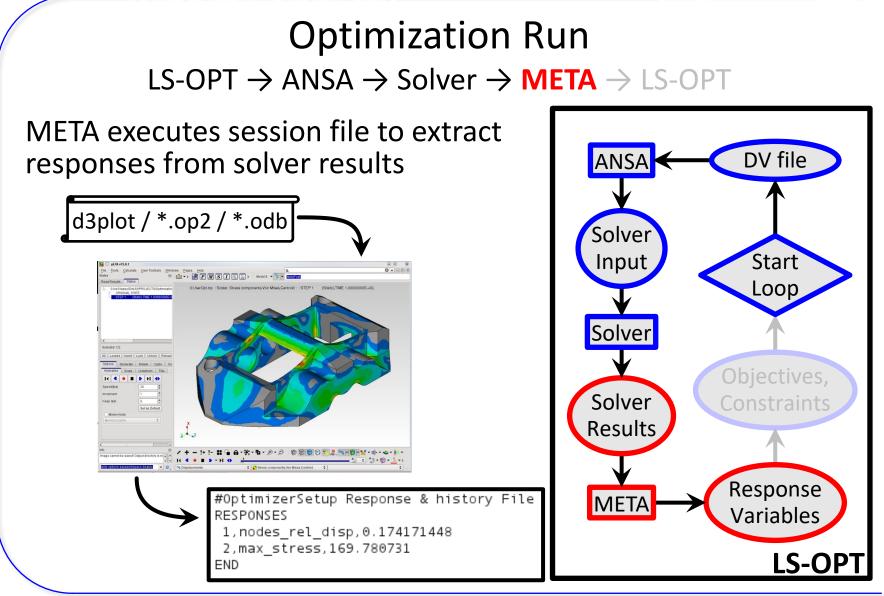
#### **Optimization Run** LS-OPT $\rightarrow$ ANSA $\rightarrow$ **Solver** $\rightarrow$ META $\rightarrow$ LS-OPT

• LS-OPT invokes solver runs







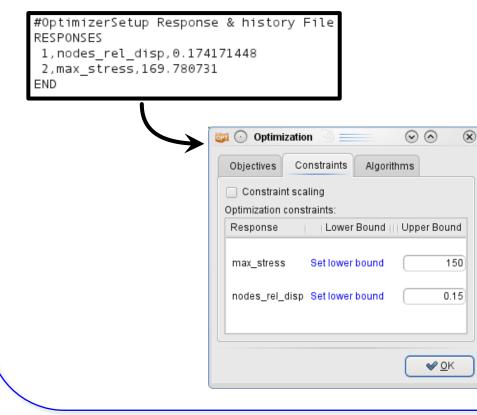


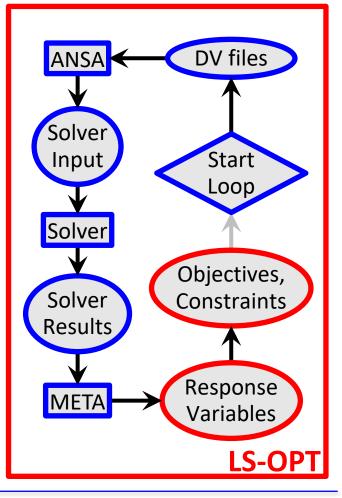
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#### $\mathsf{LS}\text{-}\mathsf{OPT} \rightarrow \mathsf{ANSA} \rightarrow \mathsf{Solver} \rightarrow \mathsf{META} \rightarrow \mathsf{LS}\text{-}\mathsf{OPT}$

# LS-OPT reads responses and evaluates objectives/constraints

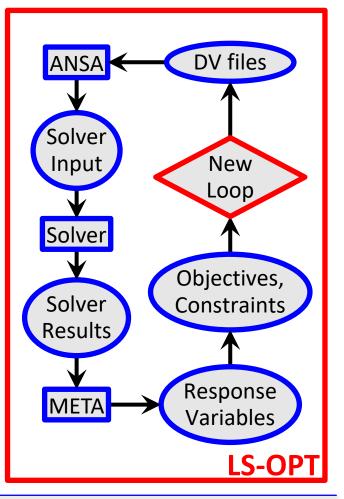






#### $\textbf{LS-OPT} \rightarrow \textbf{ANSA} \rightarrow \textbf{Solver} \rightarrow \textbf{META} \rightarrow \textbf{LS-OPT}$

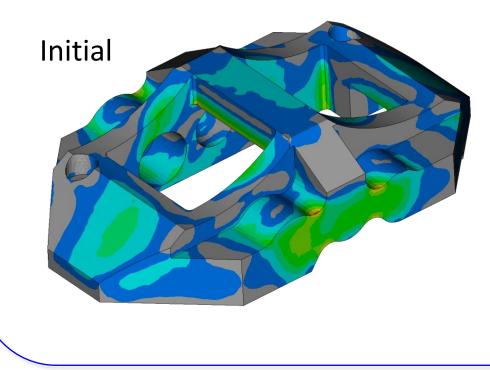
• LS-OPT calculates new values for DVs

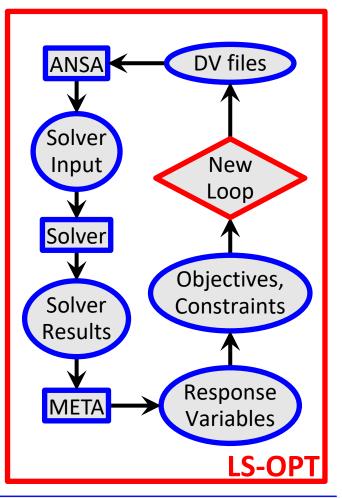




 $\textbf{LS-OPT} \rightarrow \textbf{ANSA} \rightarrow \textbf{Solver} \rightarrow \textbf{META} \rightarrow \textbf{LS-OPT}$ 

- LS-OPT calculates new values for DVs
- Whole process repeated until optimal solution

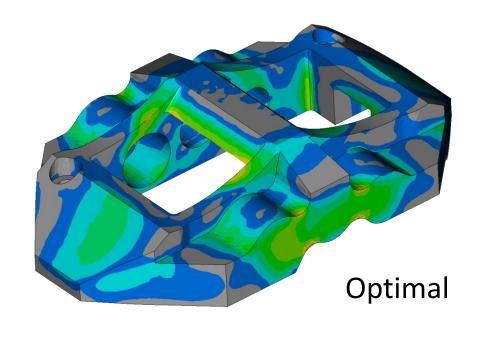


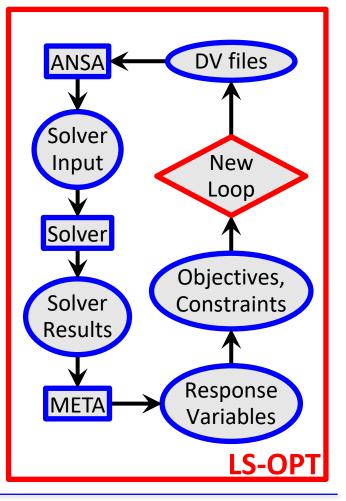




 $\textbf{LS-OPT} \rightarrow \textbf{ANSA} \rightarrow \textbf{Solver} \rightarrow \textbf{META} \rightarrow \textbf{LS-OPT}$ 

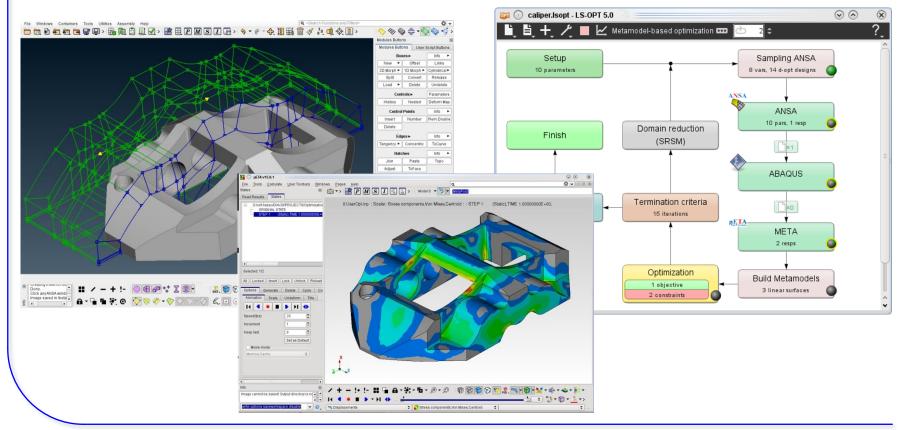
- LS-OPT calculates new values for DVs
- Whole process repeated until optimal solution







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