

modeFRONTIER Configuration

Topic: Optimization modeFRONTIER

Approved By: Terje Rølvåg

Name: Espen Nilsen, Carl Skaar

Date: 10.04.2013

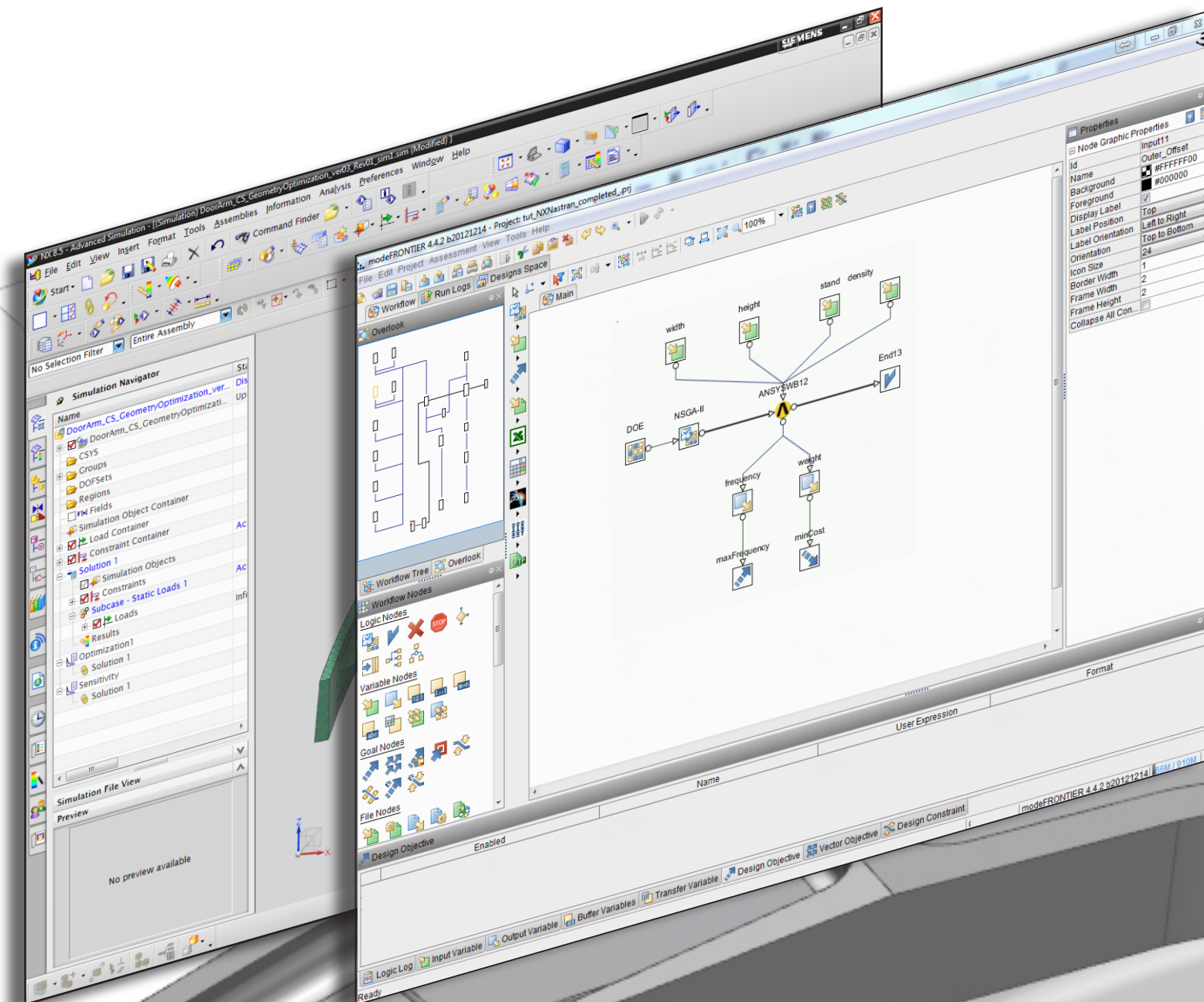
modeFRONTIER is a multiobjective optimization software which allows you to connect several different CAD or FEA software together. Through the graphical interface you are able to set up a workflow consisting of nodes (the icons) and links (lines between the nodes)

We will here demonstrate how it is possible to build a workflow which can interact with simulations performed with NX Advanced Simulations.

The objectives of this simulation will be mass and displacement.



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Topic: Necessary Preparations

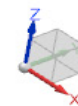
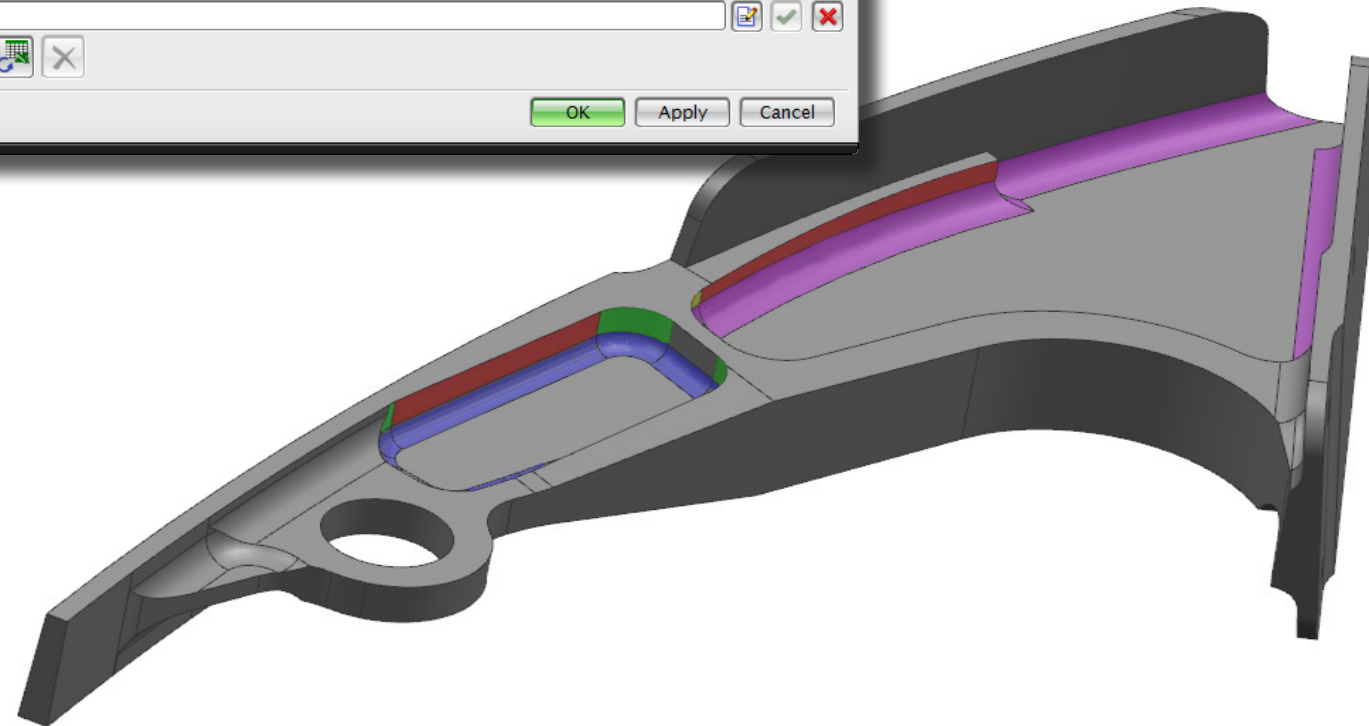
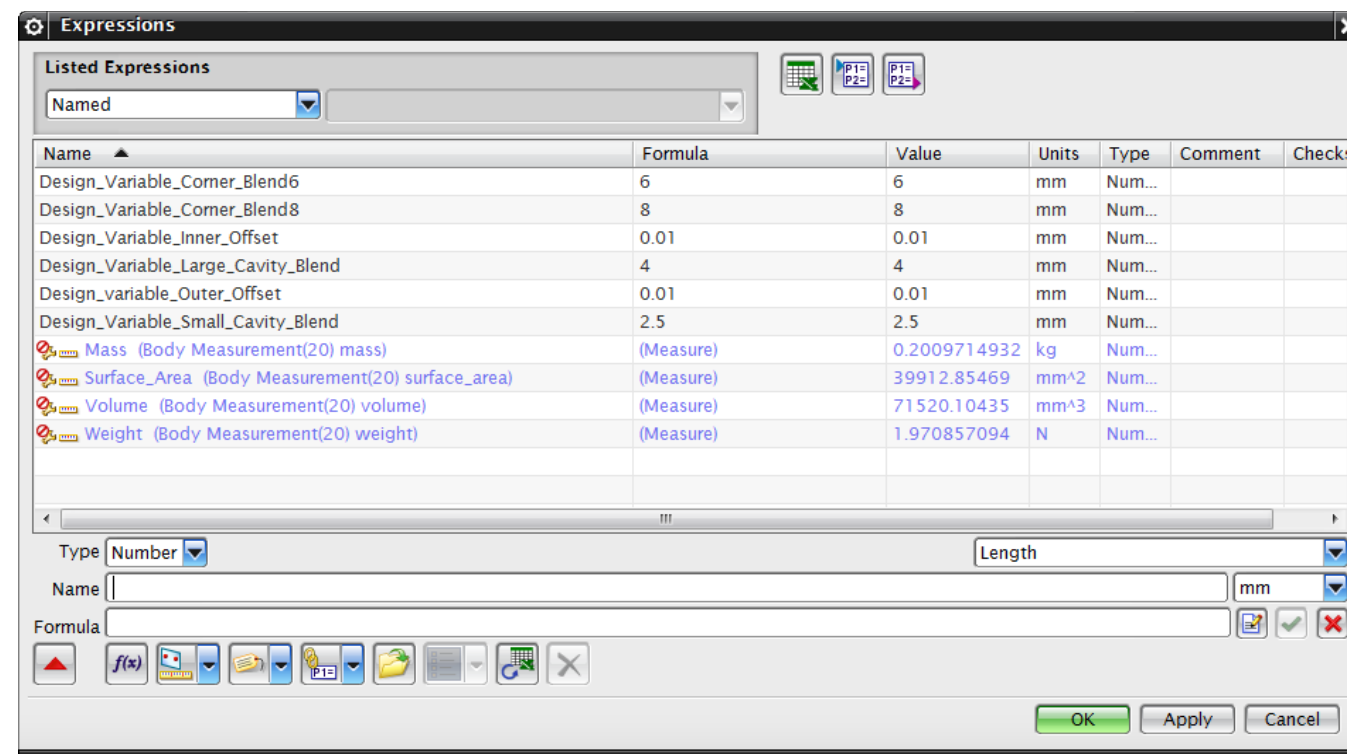
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The following preparations are necessary in order to run the optimization.

1. Parameterize the model (Expressions) in NX
2. Use Measure Bodies (Analysis --> Measure Bodies) to apply measurements like volume, mass, etc to the expressions list
3. Run a simulation i NX Advanced Simulation. Make sure you have a .fem- and .sim-file which you store in the same folder as the .prt-file
4. Install modeFRONTIER. It is recommended to install it in a directory path without spaces.
5. Download Cygwin (cygwin.com). Install it in c:\cygwin\ if possible
6. In addition you need the File killer.vbs stored in the same folder as the rest of the modeling and simulation files
7. You will also need to record a macro with meshing and simulation. Store the macro in the same folder as the rest of the files. Watch the instruction video (NX_macro.mp4)



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Topic: Workflow in modeFRONTIER

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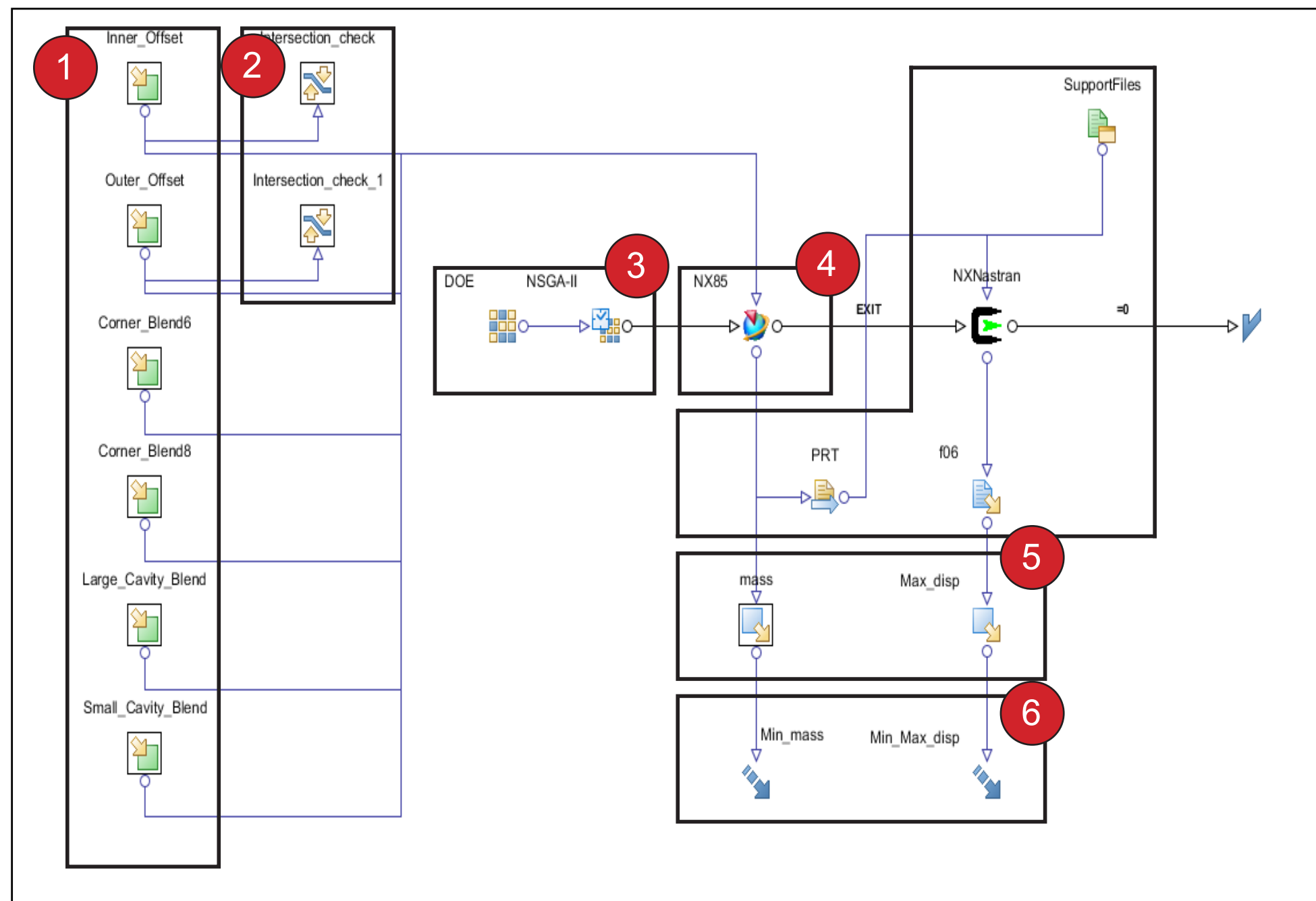
Date: 10.04.2013

The workflow shows how modeFRONTIER can control NX and NX Advanced Simulation to optimize a prt-file

The following nodes are necessary to run a optimization run:

- 1. Input Variables:** defines design space
- 2. Constraints:** constraints on variables.
- 3. DOE and Scheduler:** DOE and algorithms provides different values for the input variables
- 4. NX CAD Node:** Interacts with NX expressions
- 5. Output Variables:** design output variables
- 6. Objective:** minimizing or maximizing output variables

The last bulk consists of four nodes that are necessary to derive data outputs from NX Advanced Simulations.



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Topic: Define Input Variables

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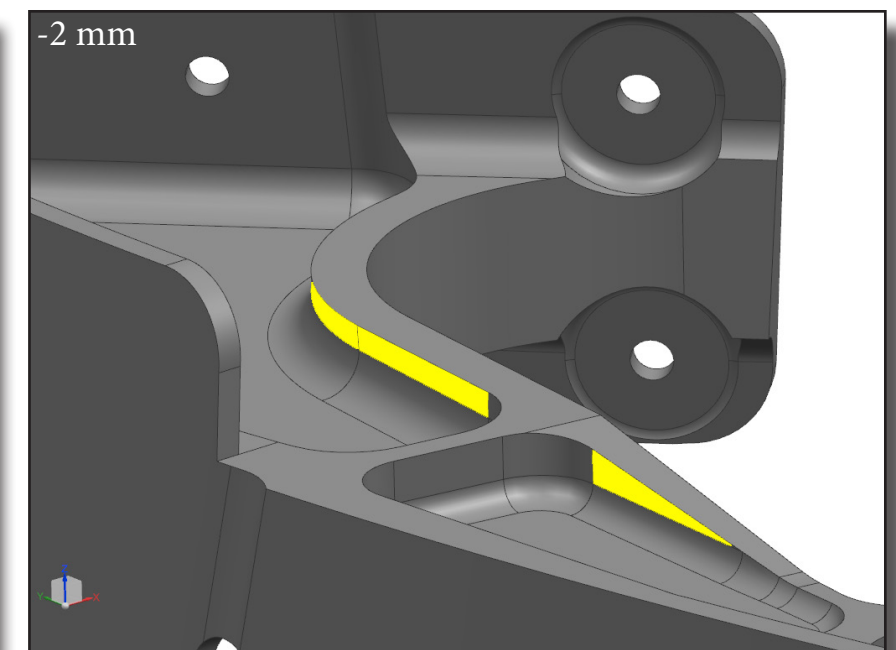
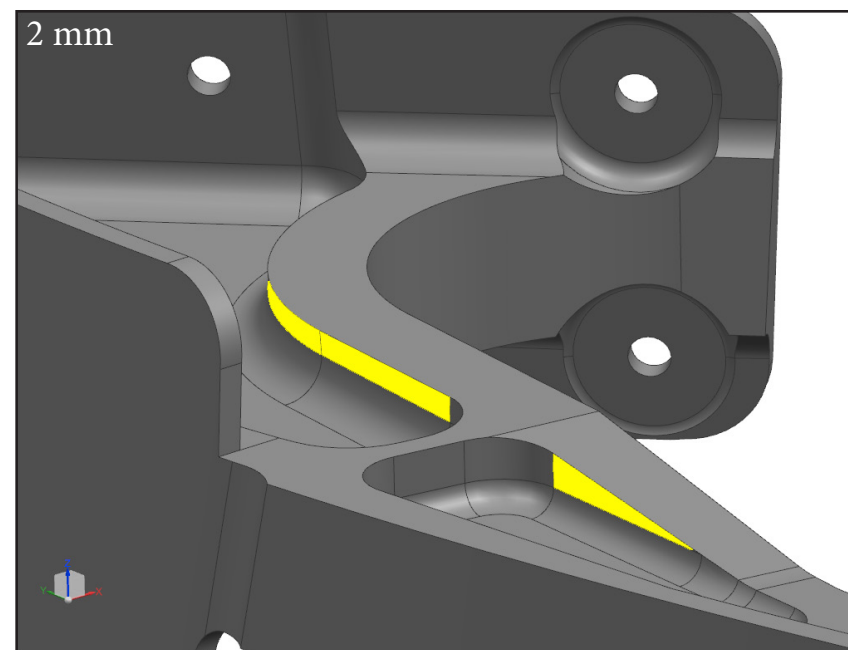
Input variables: Defines the design space by the upper and lower bound

The value range (design space) needs to be defined in order to run a successful optimization run.

1. Open the Input Variable Properties by double clicking the input node icon.
2. Under Range Properties you are able to specify the lower and upper bound for the design parameter. This tells the scheduler what range it should keep within while changing the design parameter.

The screen shots underneath shows how the CAD model responds when the parameter inner_offset is changed.

Input Variable Properties			
Input Variable Properties			
Name	Inner_Offset		
Description			
Format	0.0000E0		
Variable Type	Variable		
Range Properties			
Lower Bound	-2.0	Central Value	0.0
Upper Bound	2.0	Delta Value	2.0
Base Properties			
Base	0		
Step	0.0		
Tolerance	0.0		
Arrangement	Ordered		
MORDO Properties			
Distribution	None	Empty	Empty
Data Output Connector			
Intersection_check			
NX85			



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Topic: Define Input Constraint

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Design Constraint: Additional constraints added to the output or input variable

It is also possible to define additional constraints to the Input or output variable. If one of the design parameters for instance can't be equal to zero, a constraint node can be linked to the input variable node.

1: What is needed to be defined here is the "User Expression" and "Limit". To edit the user expression, click the calculator icon behind the "User Expression".

2: In this case the expression is written the absolute value of the input variable. The variables connected to the constraint node will occur in a list to the left. Click "Apply" to save the changes. You will then return to the Constraint Properties. Set the limit equal to zero. Save the changes and close the window by clicking "Ok".

Constraint Properties	
Name	Intersection_check
Description	Offset > 0
Enabled	<input checked="" type="checkbox"/>
Format	0.0000E0
Constraint Expression Properties	
User Expression	abs(Input_Variable)
Type	Greater Than
Limit	0.0
Tolerance	0.0

.....

Data Input Connector	
Input_Variable	

OK Cancel Help

Variables	Expression
Input_Variable	1 abs(Input_Variable)

Basic Functions: sin, cos, tan, degToRad, asin, acos, atan, radToDeg, log, ln, exp, sqrt, abs, sgn, rand, pow, ceil, floor, round, mod, min, max, interp, vect

Operators: ~, &, |, !, (,), >, <, [,], %, ., =, 7, 8, 9, /, CA, 4, 5, 6, *, <-, 1, 2, 3, +, ., 0, E, PI, -, End

Apply Cancel

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Topic: DOE and Schedulers

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Design of experiments (DOE): Necessary sample of the design space which the scheduler algorithm can base its optimization algorithms on.

From the DOE Properties you can choose what kind of DOE setting you will like to use. In this tutorial we will use the Uniform Latin Hypercube.

- 1: Remove the DOE design table by holding shift and mark all the lines. Press "Delete"
- 2: Use the same properties as specified and click "Add DOE Sequence"
- 3: Click "Ok" to save and close the window.



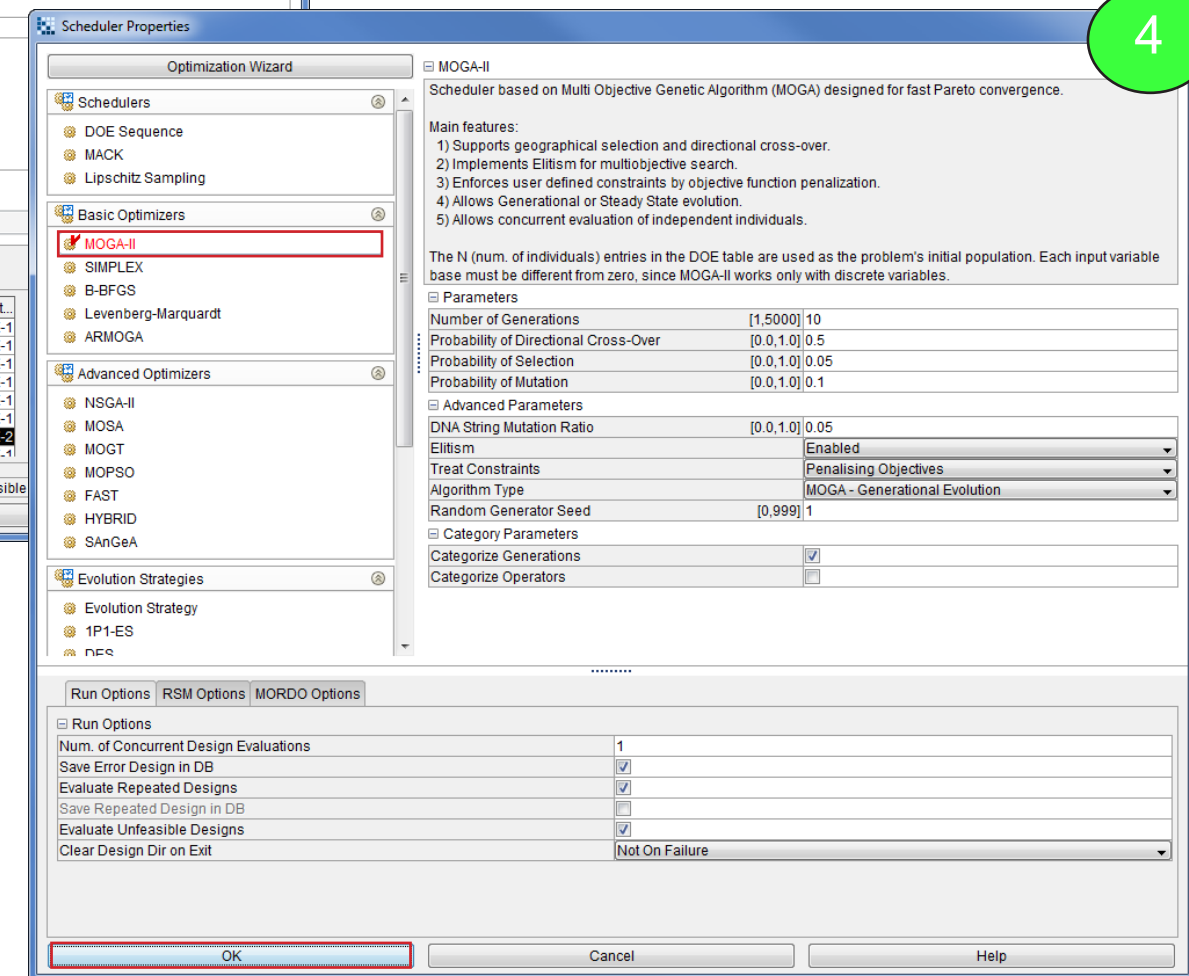
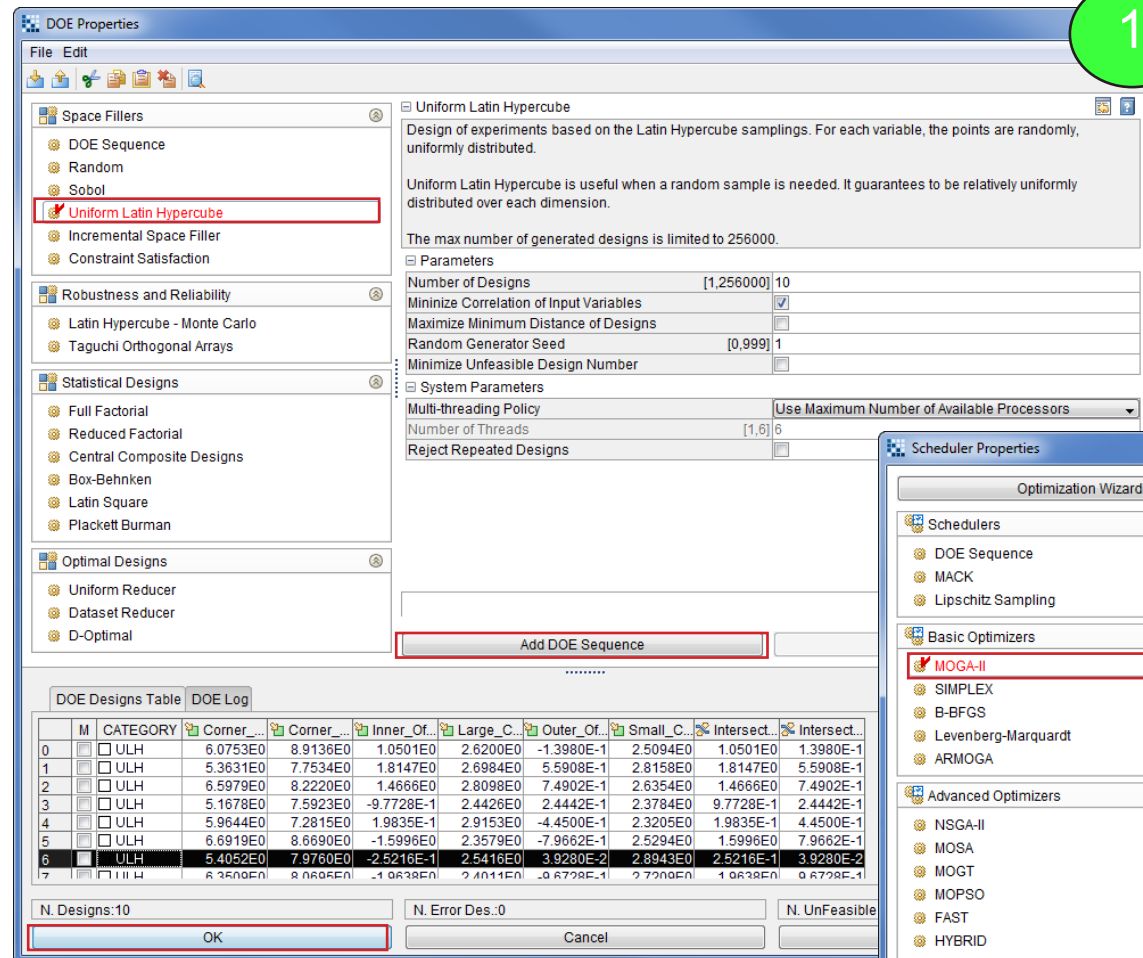
Scheduler: Contains different types of algorithms that work in various ways to reach optimization goals based on the problem at hand.

The scheduler uses the initial DOE to build a population of new designs. The way it controls the evolution varies from algorithm type selected.

As a example we will use the scheduler called MOGA-II.

- 4: Select "MOGA-II" from the list to the left
- 5: Click "Ok" to save and close the window.

Look in the help section for more details regarding DOE and Schedulers



modeFRONTIER Configuration

Topic: Assign Input/Output Variables from part-file.

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Date: 10.04.2013



NX CAD Node: interact with the user expressions in a NX .prt-file.

The NX CAD node can only interact with inputs and outputs involving the geometry.

1: Define all the input and output variables you would like to use by clicking on each of the binoculars behind the input variables listed under "Data Input Connector".

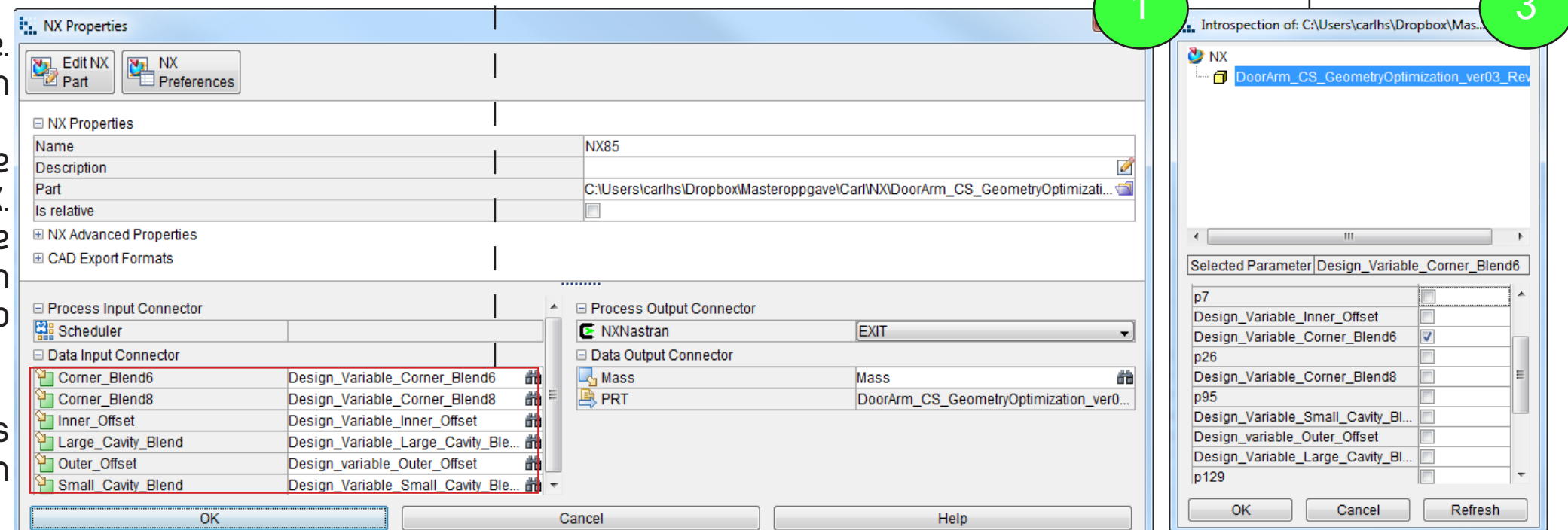
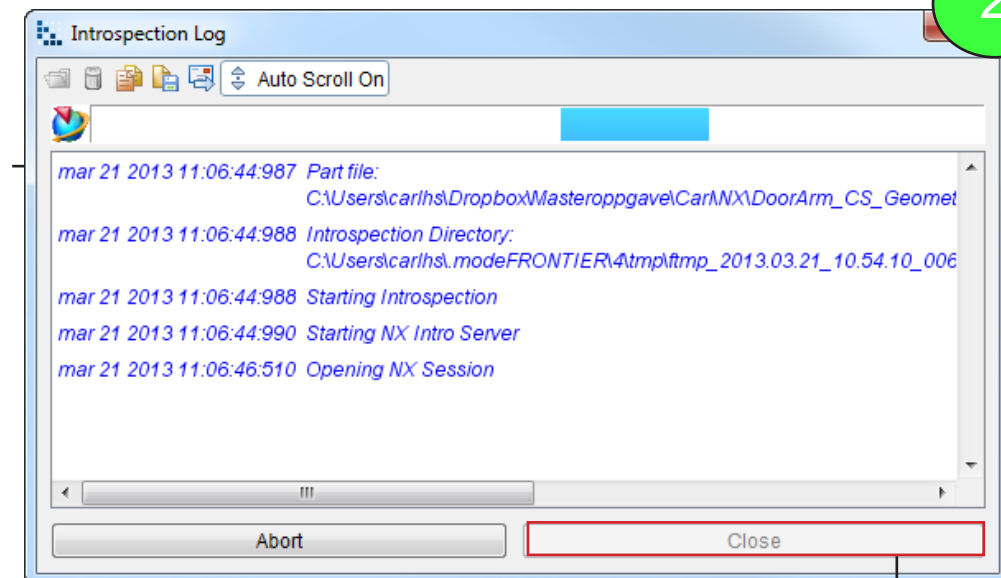
2: Wait for the introspection log to finish loading, then click close.

3: A new window will open. Click on the part name. A list will be shown underneath with all the design parameters from the expression list in NX.

4: A list will be shown underneath with all the design parameters from the expression list in NX. Tick the design parameter which corresponds to the input node you want to assign. You have to click on each binocular to assign one design parameter to each of the input nodes.

5: The same way you assign the output variables. You will need to apply all the input and output nodes you need in the workflow to be able to assign each and every one of them.

The data output connector called PRT is for the simulations results and has no binoculars.



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Topic: Define Objective

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Date: 10.04.2013



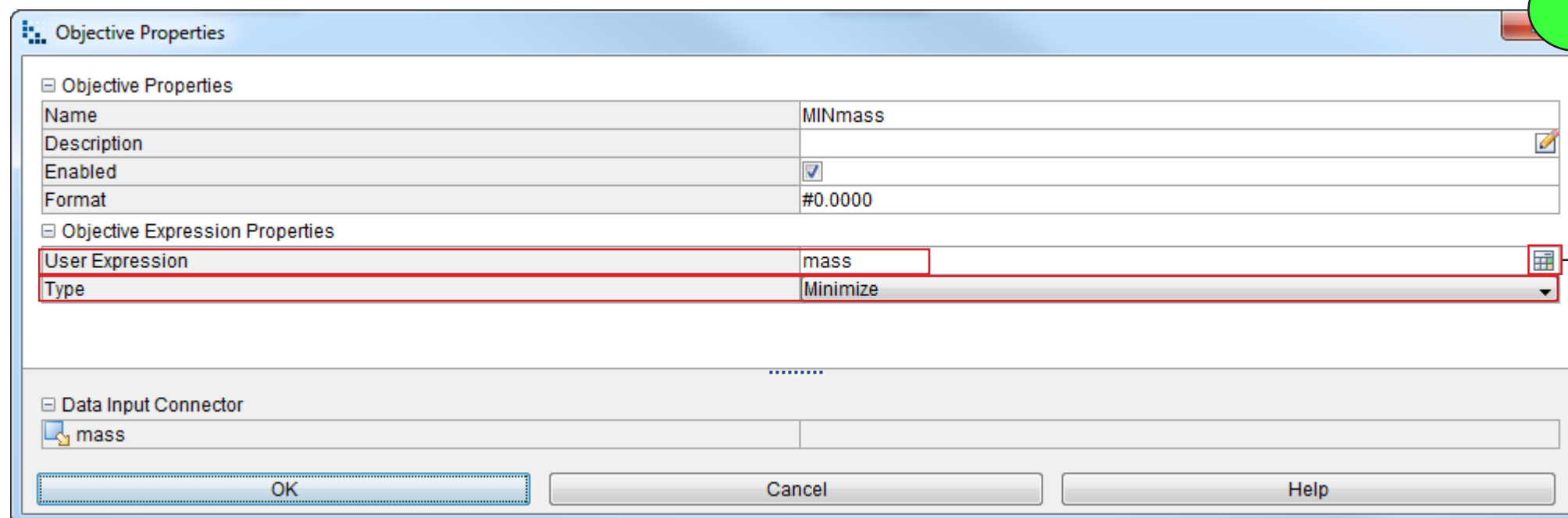
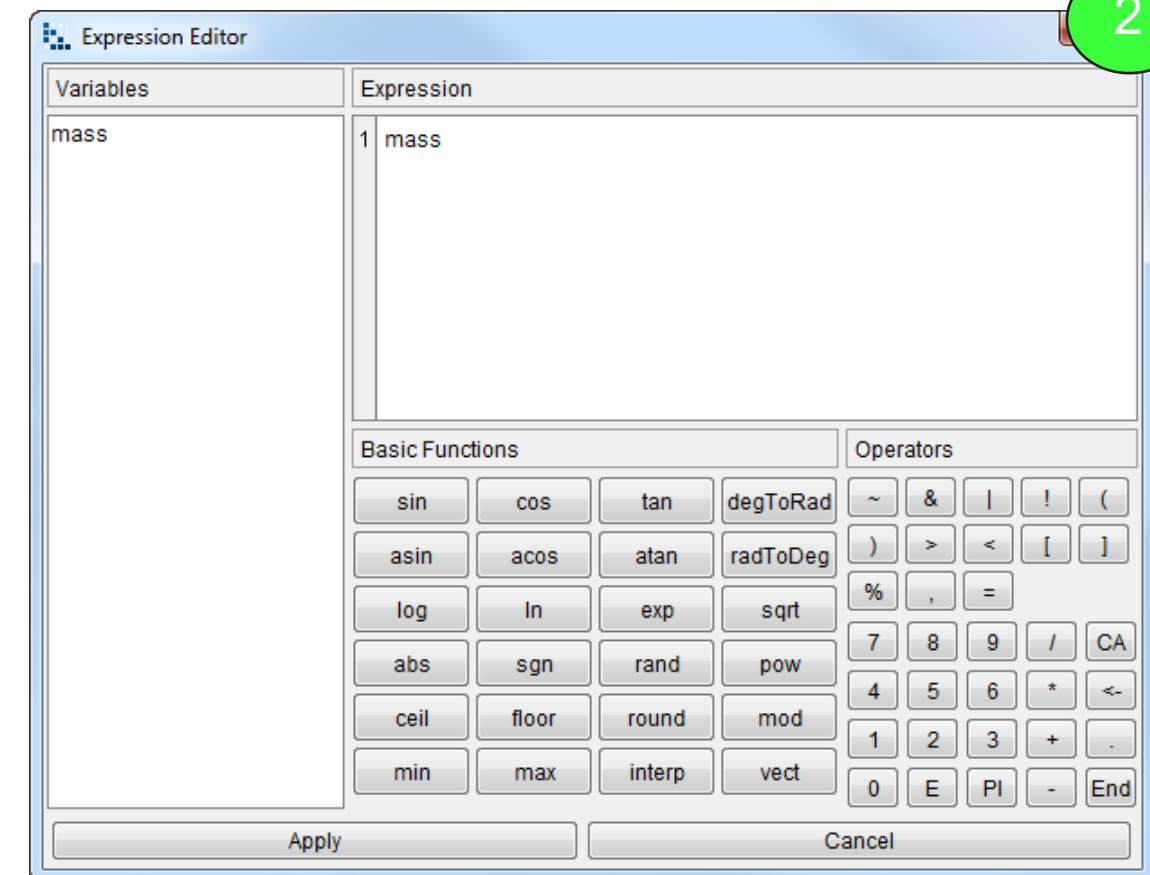
Design Objective: Identifies the output node and represents the optimization objective

The objective node is connected to output node and allows you to either minimize or maximize the output.

1: Double-click the objective node. The objective node is linked to a output node called "mass". Click on the calculator.

2: In the Expression Editor define the expression output value through the calculator icon.

Under "Type" you could either choose minimize or maximize depending on the objective for the variable chosen.



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Topic: Retrieving Simulations Outputs (displacement)

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Date: 10.04.2013

The NX geometry node is only able to deal with the expressions defined in the .prt-file. Unfortunately, there is no standard simulation node which can interact with NX Advanced Simulations. The way of retrieving simulation results into modeFRONTIER is to use the Cygwin node. The Cygwin node allows you to run a Script which will run the macro recorded in NX.



Transfer File: Transfers File(s) from one application node to another.



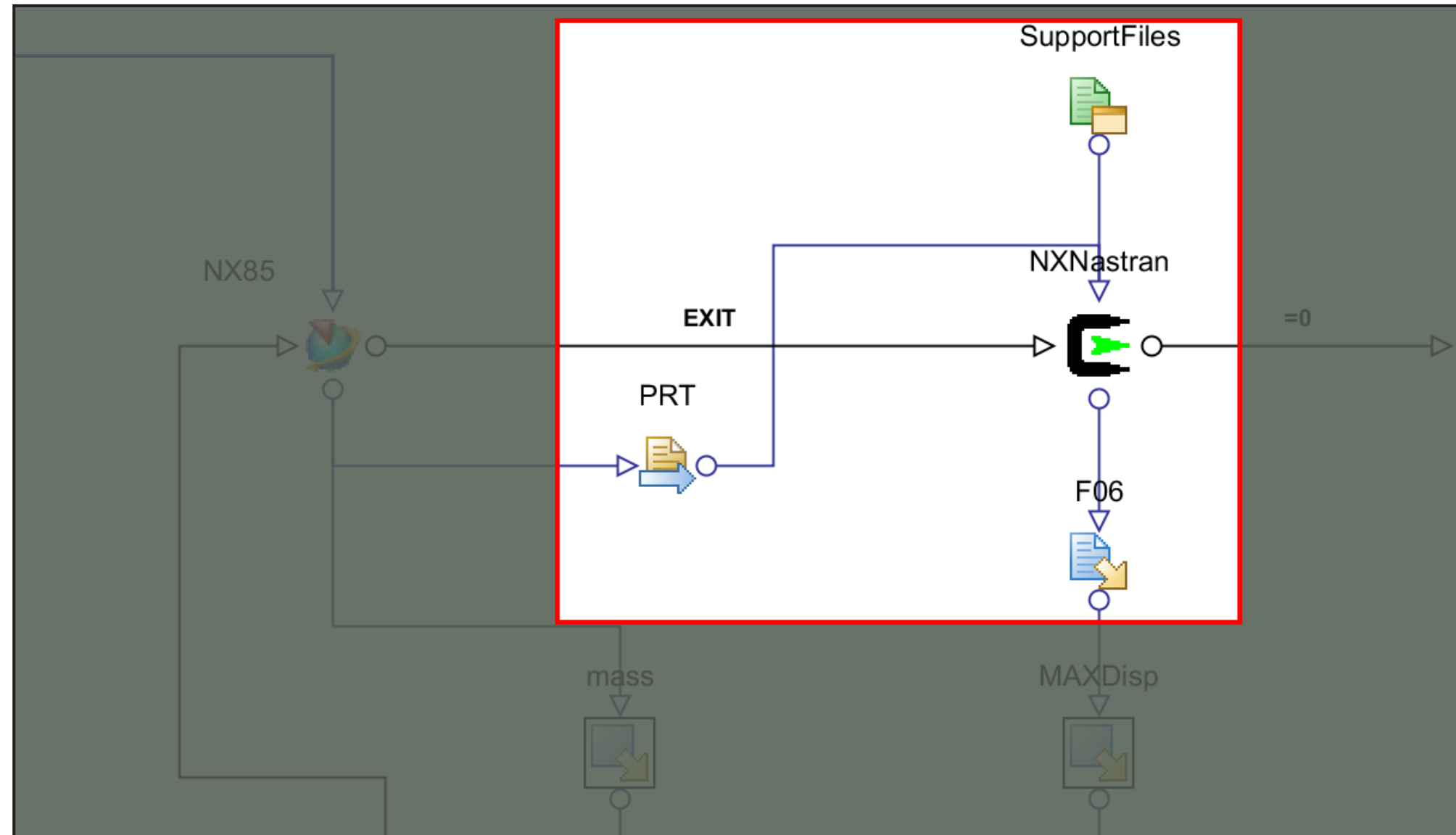
SupportFiles: Shows the absolute path for all the files included in the script



Cygwin Shell Script: Executes a script which will load NX and run a macro



Output File: Uses a mining rule which is able to read results out of the .F06 File.



In the next slides we will show you how each of the nodes needs to be defined, changes needed to be done in the script, and how to record a macro in NX 8.5.



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Topic: Write Results to the .F06-file

Approved By: Terje Rølvåg

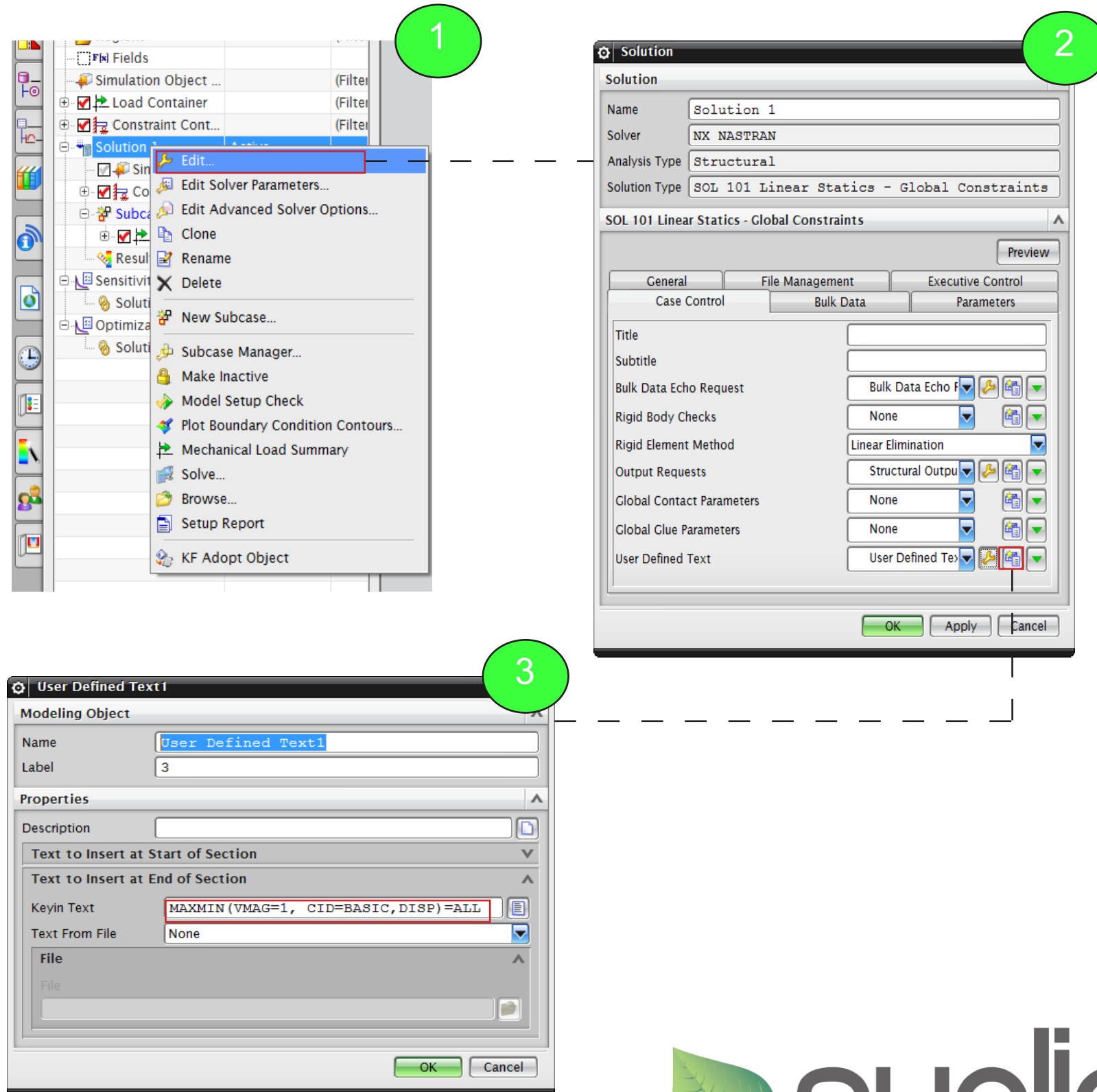
Name: Espen Nilsen, Carl Skaar

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In order to extract the maximum displacement magnitude, this setting needs to be configured in NX

- 1: Open the .sim-file and right-click on the solution.
- 2: Click on the icon "Creating Modeling Object"
- 3: In the "Keyin Text" input box, copy-paste:

MAXMIN(VMAG=1, CID=BASIC, DISP)=ALL



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Topic: Record the macro

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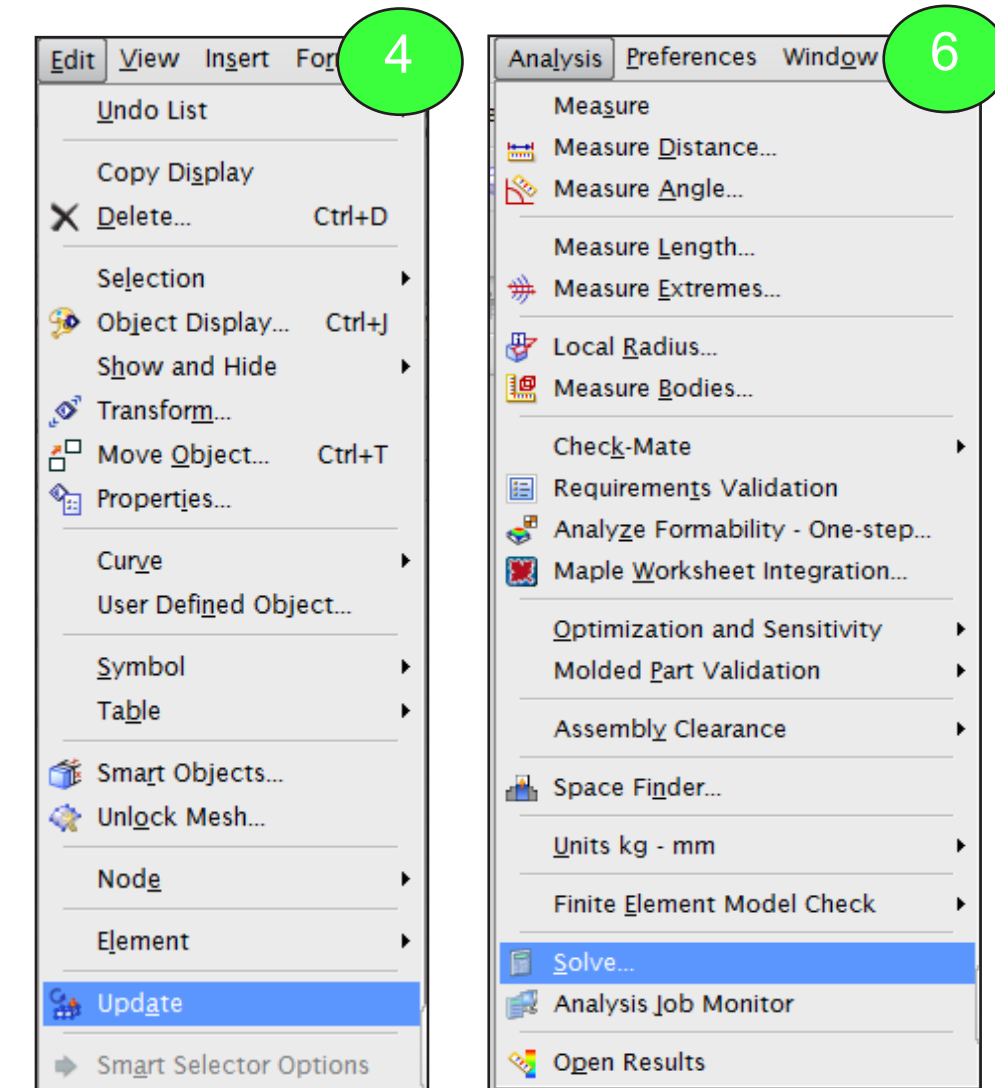
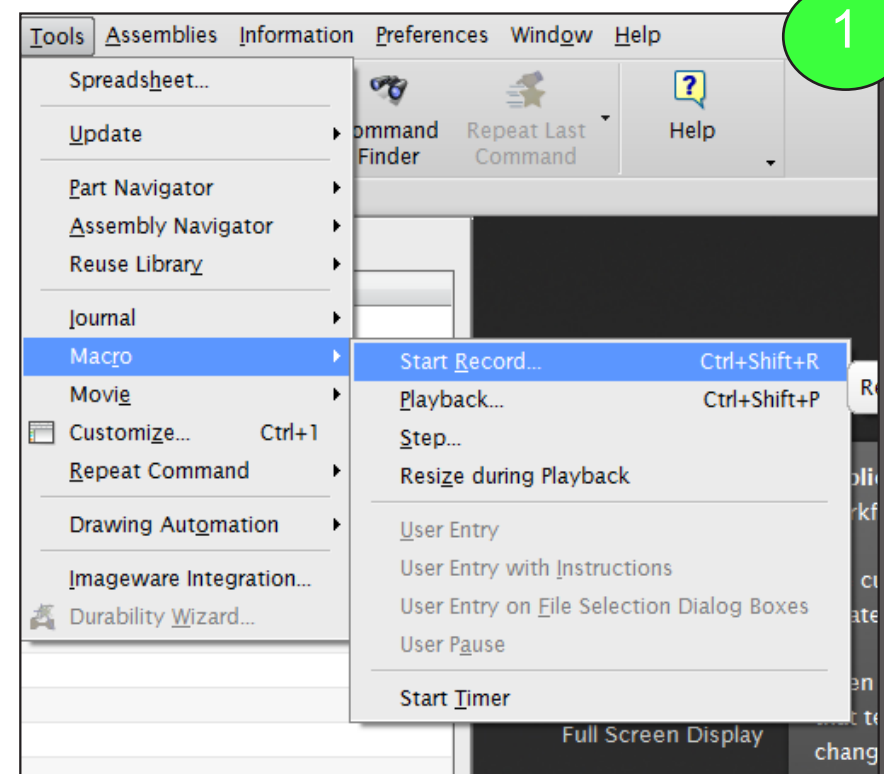
Name: Espen Nilsen, Carl Skaar

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A macro needs to be recorded in NX in order to run the simulations. It is important to do this exactly as described here, in order to make this work.

Before recording the macro, make sure you have a .prt, .fem and .sim file. Save the part file without updating the finite element model so the update finite element model button is clickable.

- 1: Start recording the macro from Tools --> Macro --> Start Recording. Name the macro "NX_Macro"
- 2: Open the part-file (File --> Open)
- 3: Open the .fem file (File --> Open)
- 4: Update the finite element model (Edit --> Update)
- 5: Open the .sim file (File --> Open)
- 6: Run the analysis (Analysis --> Solve)
- 7: Let the simulation finish and close NX without saving (File --> Exit)



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Topic: Transfer File and Support Files

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Transfer File: Transfers File(s) from one application node to another.

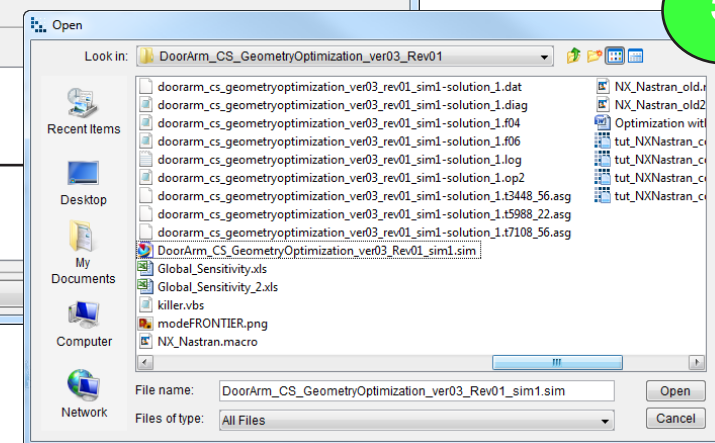
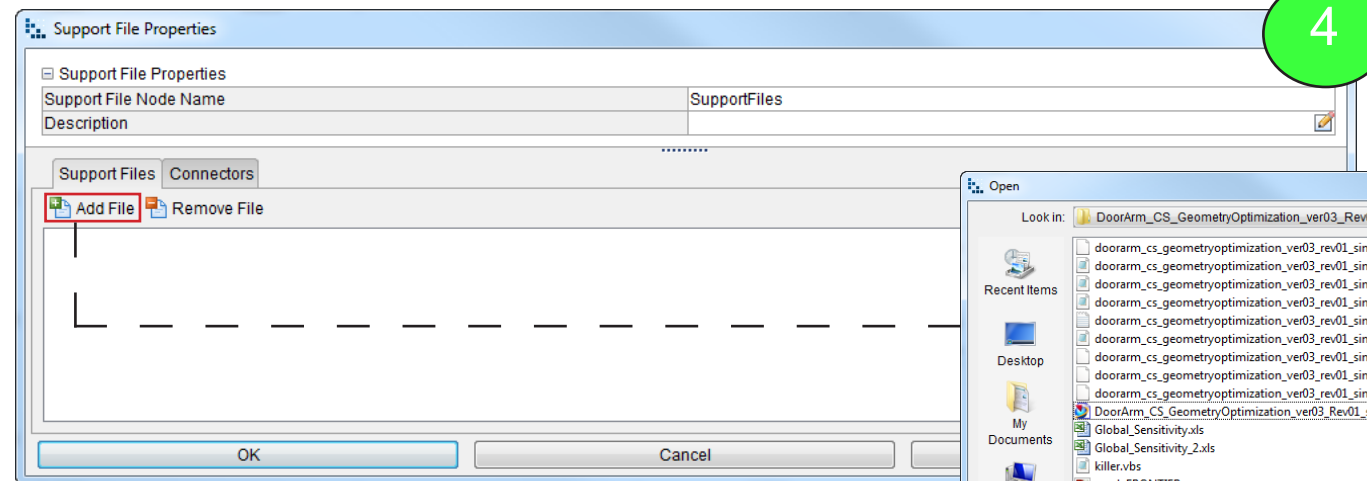
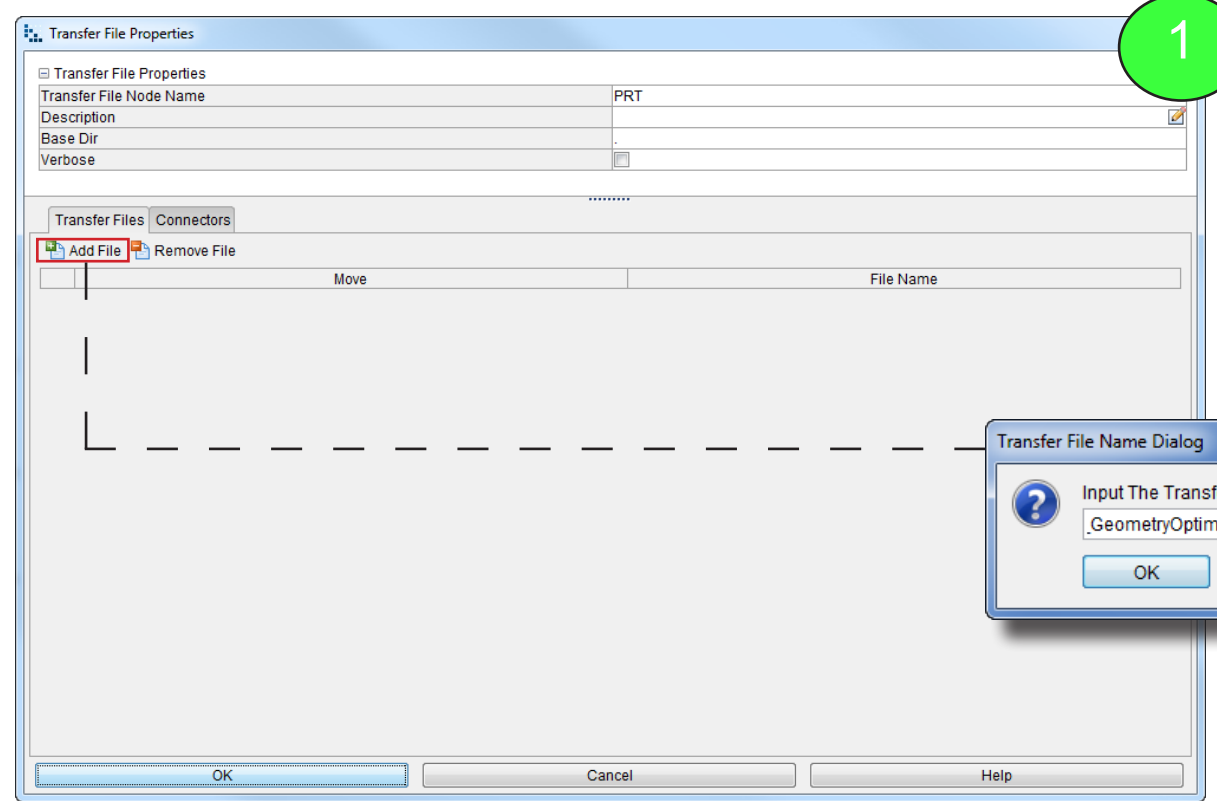
In order to get displacement as output on each of the design iterations the transfer node is needed. The node makes a temporary copy of each of the generated designs and couples it with the cygwin node.

- 1: Click on Add File
- 2: Write the .prt-file name. Since you want the temporary copy of the file, insert: filename_copy.prt.
- 3: If there is other files in the list, remove them by clicking Remove File.



SupportFiles: Shows the absolute path for all the files included in the script

- 4: Click on Add File
- 5: Choose the five files: .prt, .fem, .sim, killer.vbs and NX_Nastran.macro.
- 6: If there is other files in the list, remove them by clicking Remove File.



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Topic: Cygwin Shell Script

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Cygwin Shell Script: Executes a script which will load NX and run a macro

1: There are no changes needed to be done in the main window. Go ahead and click on "Edit Cygwin Script"

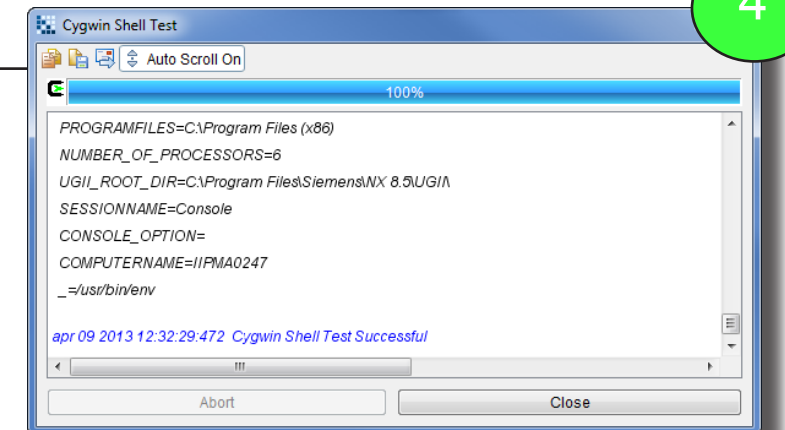
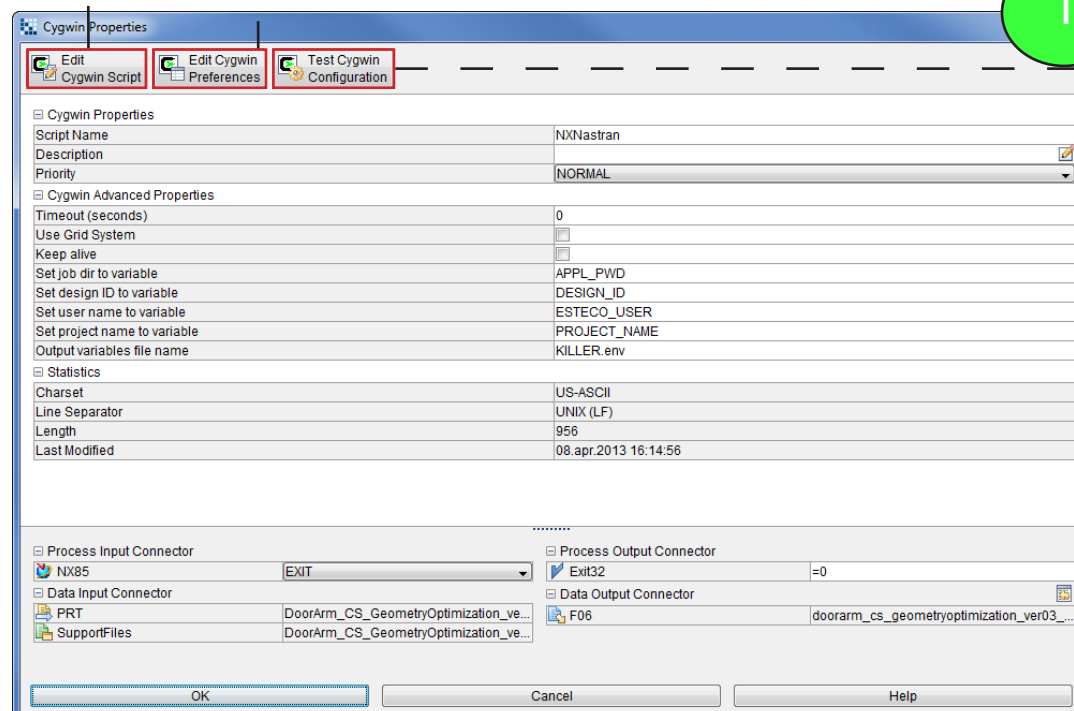
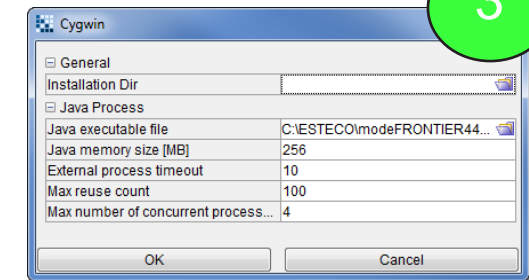
2: All the text marked within a red box on the picture underneath needs to be updated with the correct filenames. This involves the .prt-file, the copy of the .prt file and the .F06 resultfile. These can be picked from the list to the left.

3: If the NX does not open during the run, define the java executable file. Do this by specifying the path for java.exe. Normally this is stored in modeFRONTIER installation folder:

(c:\ESTECO\modeFRONTIER442\jre\bin\java.exe)

4: Check if the script is able to load.

```
1#!/bin/sh
2
3typeset -i time=0
4typeset -i timeout=120
5
6mv DoorArm_CS_GeometryOptimization_ver03_Rev01_copy.prt DoorArm_CS_GeometryOptimization_ver03_Rev01.prt
7
8ugii.bat -key:NX_Nastran.macro
9
10while [ 1 -eq 1 ]
11do
12    if [ ${time} -gt ${timeout} ]
13    then
14        echo ">> NX-Nastran run failed! Killing NX-Nastran process"
15        UGS_pid=$(ps -W | grep "ugraf.exe" | awk 'NR==1{print$1}')
16        cscript //B killer.vbs ${UGS_pid}
17        NX_pid=$(ps -W | grep "nastran.exe" | awk 'NR==1{print$1}')
18        cscript //B killer.vbs ${NX_pid}
19        exit 2
20    fi
21
22    if [ -f doorarm_cs_geometryoptimization_ver03_rev01_sim1-solution_1.f06 ]
23    then
24        NX_n=$( grep -c "END OF JOB" doorarm_cs_geometryoptimization_ver03_rev01_sim1-solution_1.f06 )
25        if [ ${NX_n} -eq 1 ]
26        then
27            echo ">> NX-Nastran run completed!"
28            exit 0
29        fi
30    fi
31
32    echo ">>> NX-Nastran is running...."
33    sleep 1
34    time=$((time+1))
35done
36
37exit 0
```



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Topic: Retrieving Simulations Outputs (displacement)

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Output File: Uses a mining rule which is able to read out results from the .F06 file and assign it to the output variable

- 1: Click on "Open Output File"
- 2: Click open to update the .F06 File
- 3: Browse to the .F06 File and double-click it.

There is already a mining rule defined. If you need to add a new mining rule for displacement:

- 5: Mark the text "Displacement"
- 6: Right-click and choose "Relative Position"
- 7: Mark the value you will like obtain from the .F06-file, left
- 8: Right-click and choose "Select Relative". Displacement should become green, and the value red.

Finally, run the analysis by clicking project --> run

Output File Properties

Output File Node Name	F06
Description	
Output File Name	doorarm_cs_geometryoptimization_ver03_rev01_sim1-solution_1.f06
Include Template in Project	<input checked="" type="checkbox"/>
Charset	windows-1252
Data Input Connector	NXNastran
Data Output Connector	MAXDisp

Template Output Editor

DAREA	ID	TYPE	T1	T2	T3	R1	R2	R3
0	1	FX	3.004678E+05	---	---	---	6.633212E+07	-1.879538E+08
0		FY	---	2.472402E+06	---	-5.514904E+08	---	5.430838E+07
0		FZ	---	---	-1.486415E+00	1.194822E+05	5.965968E+05	---
0		MX	---	---	---	0.000000E+00	---	---
0		MY	---	---	---	---	0.000000E+00	---
0		MZ	---	---	---	---	---	0.000000E+00
0		TOTALS	3.004678E+05	2.472402E+06	-1.486415E+00	-5.513709E+08	6.692871E+07	-1.336454E+08

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DISPLACEMENT MAX / MIN VALUE SUMMARY

POINT ID	TYPE	CID	T2	T3	R1	R2
9167	G	BASIC	0.000000E+00	0.000000E+00	0.000000E+00	0.000000
20305	G	BASIC	4.977476E-01	0.000000E+00	0.000000E+00	0.000000

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***** R1 *** DISPLACEMENT MAX / MIN VALUE SUMMARY RESULTS FOR SUBCASE**

Variable Name	Description	Mining Rule
<input checked="" type="checkbox"/> MAXDisp		NAME=MAXDisp, TYPE=RELATIVE, TAG=DISPLACEMENT, OCR...

Open

Look in: DoorArm_CS_GeometryOptimization_ver03_Rev01

File name: DoorArm_CS_GeometryOptimization_ver03_Rev01_sim1.sim

Files of type: All Files

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