Workshop - Responses in Design Model

AN MSC NASTRAN SOL 200 TUTORIAL

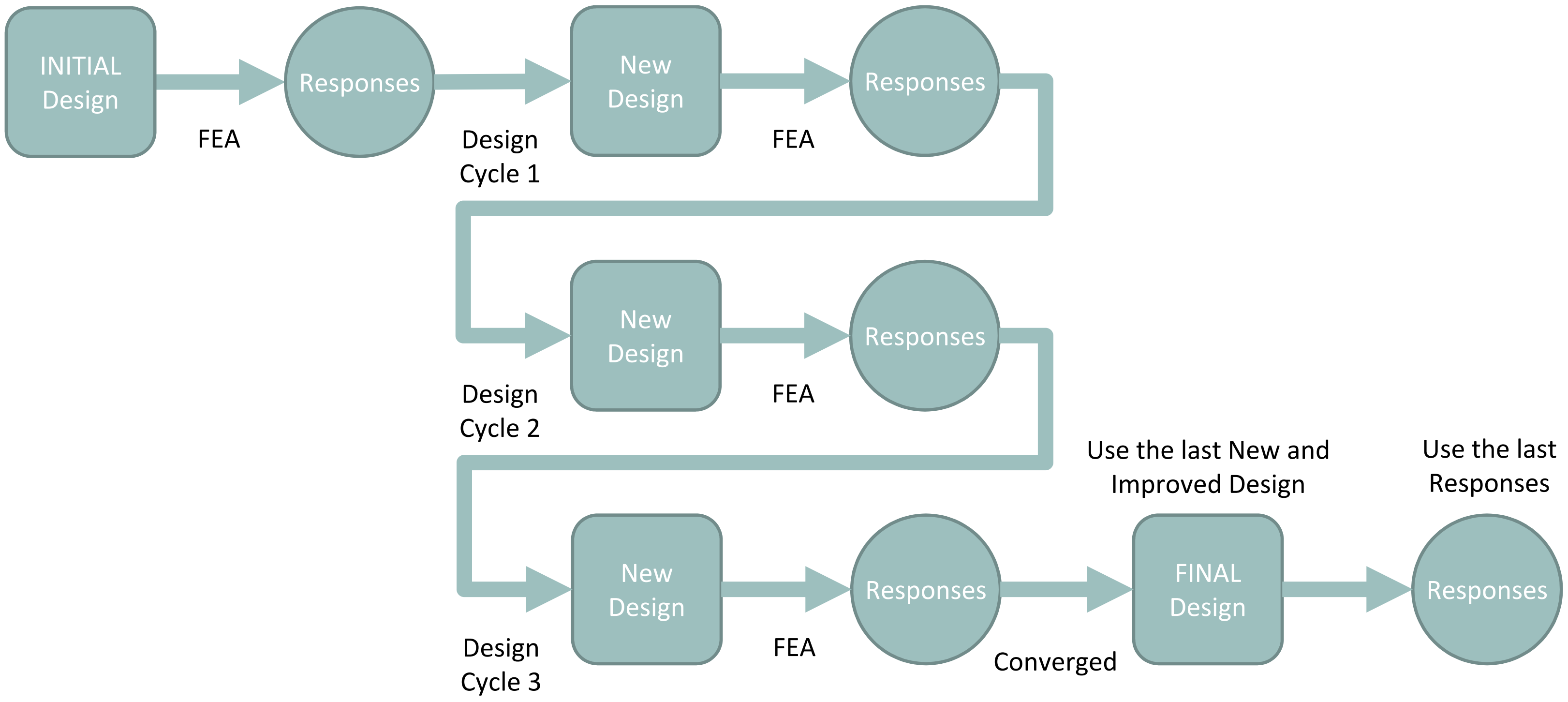
Responses in Design Model

Below are examples of responses:

- The stress of a beam
- The displacement at a node
- The weight of a structure

During an optimization, each design cycle typically produces an New Design. See the image to the right.

A Finite Element Analysis (FEA) is performed on the New Design and a new set of outputs or Responses, such as displacements, stresses, etc., are generated.



Simplified workflow of MSC Nastran Optimization procedure

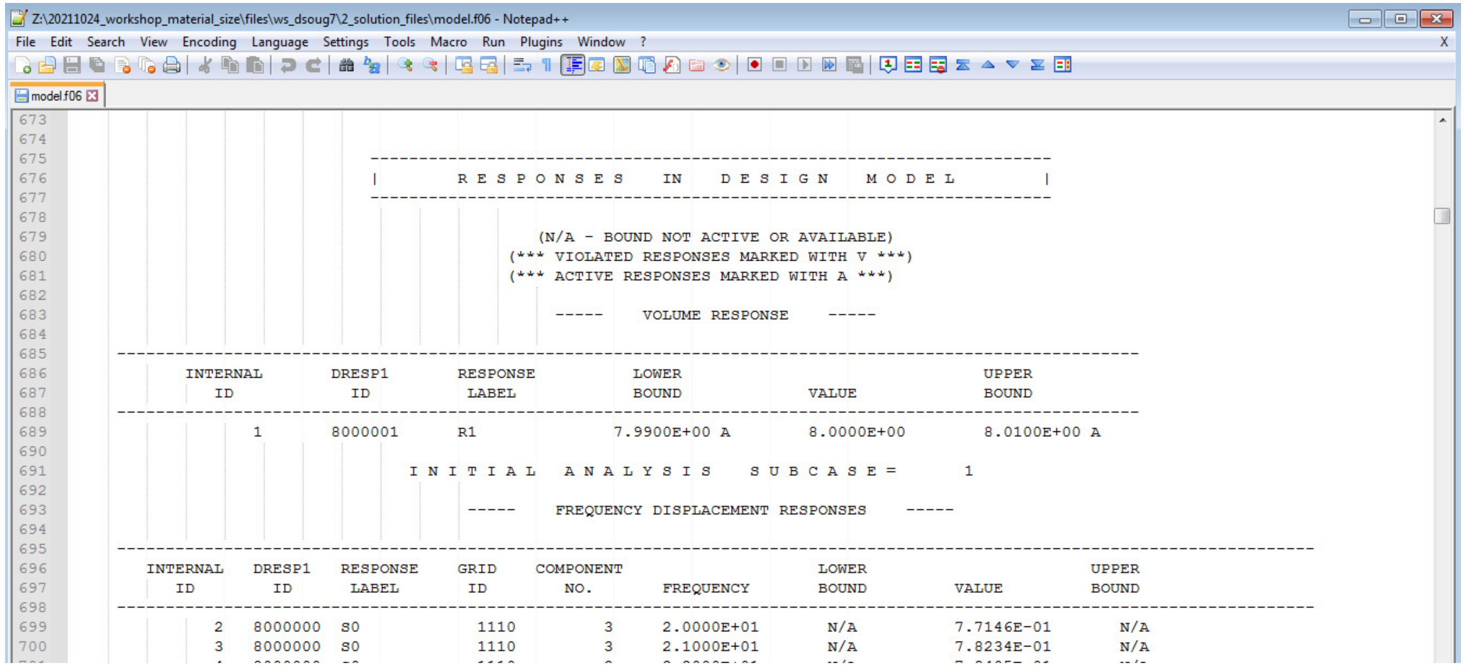
Responses in Design Model

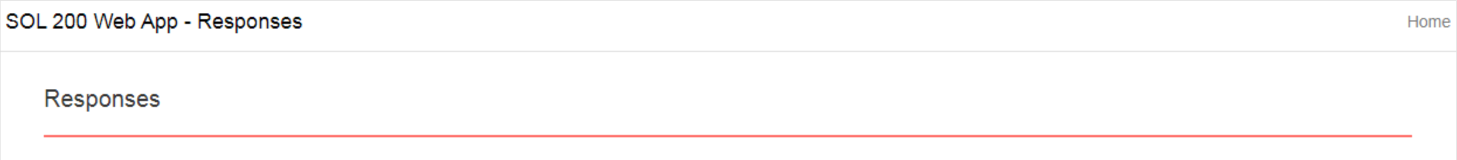
The Responses at the end of each design cycle are reported in the .f06 file.

```
                    ***********************************************************************
                    *                                                                     *
                    *                                                                     *
                    *                 D E S I G N    O P T I M I Z A T I O N              *
                    *                                                                     *
                    *                                                                     *
                    ***********************************************************************

                                 ******************************************
                                 *                                        *
                                 *       D E S I G N    C Y C L E      2  *
                                 *                                        *
                                 ******************************************

                     *****   OPTIMIZATION RESULTS BASED ON THE APPROXIMATE MODEL   *****

                                        -----   DESIGN OBJECTIVE   -----
-------------------------------------------------------------------------------------------------------------------------------
           INTERNAL                                 MINIMIZE
           RESPONSE                     RESPONSE      OR      SUPERELEMENT  SUBCASE         INPUT             OUTPUT
              ID         DRESPx           TYPE     MAXIMIZE        ID          ID            VALUE             VALUE

                    ---------------------------------------------------------------------------
                    |         R E S P O N S E S    IN    D E S I G N    M O D E L             |
                    ---------------------------------------------------------------------------

                                     (N/A - BOUND NOT ACTIVE OR AVAILABLE)
                                   (*** VIOLATED RESPONSES MARKED WITH V ***)
                                   (*** ACTIVE RESPONSES MARKED WITH A ***)

                                         -----   WEIGHT RESPONSE   -----

-------------------------------------------------------------------------------------------------------------------------------
     INTERNAL     DRESP1     RESPONSE      ROW       COLUMN        LOWER          INPUT          OUTPUT           UPPER
        ID          ID        LABEL        ID          ID          BOUND          VALUE          VALUE            BOUND
-------------------------------------------------------------------------------------------------------------------------------
         1      8000000       R0            3           3           N/A         4.8284E+00     3.0136E+00         N/A
                          D E S I G N    C Y C L E =      1    S U B C A S E =      1

                                         -----   STRESS RESPONSES   -----

-------------------------------------------------------------------------------------------------------------------------------
   INTERNAL     DRESP1    RESPONSE   ELEMENT     VIEW    COMPONENT      LOWER          INPUT         OUTPUT          UPPER
      ID          ID        LABEL       ID     ELM ID       NO.          BOUND          VALUE         VALUE           BOUND
-------------------------------------------------------------------------------------------------------------------------------
         2      8000002  R2             1                  2         N/A          1.3530E+04    1.9980E+04    2.0000E+04 A
         3      8000002  R2             3                  2     -1.5000E+04     -9.0973E+03   -1.1804E+04       N/A
```

Responses App

The Responses App allows the upload of the F06 file and displays the data from the Responses in Design Model section.





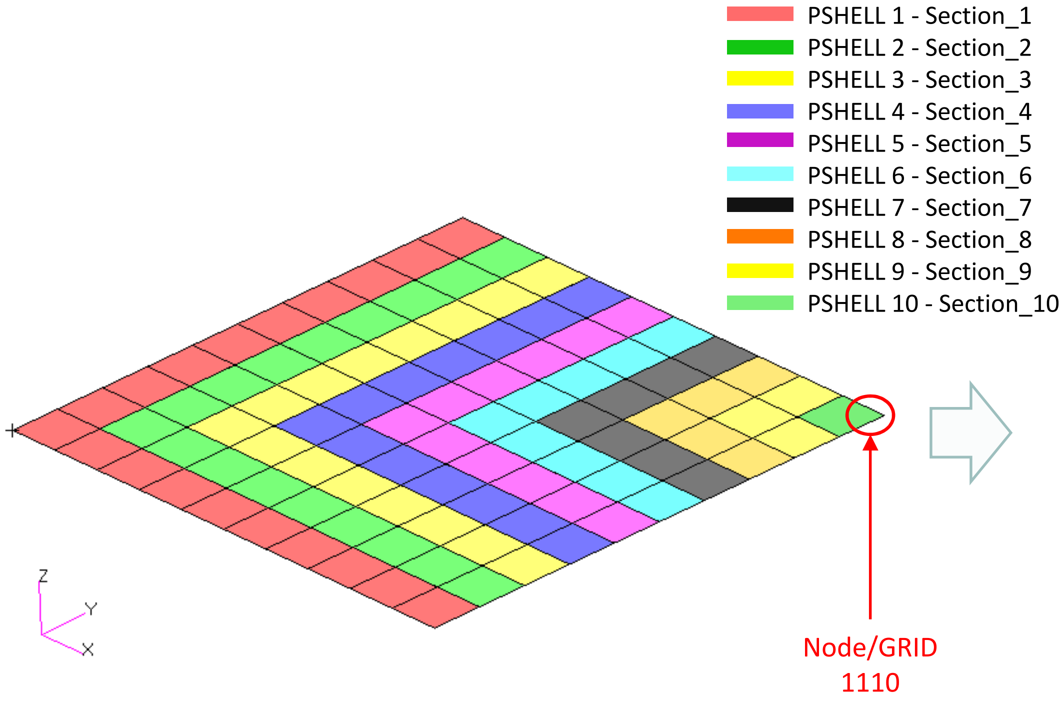
Design Cycle	Subcase	Label	Response Type	Normalized Constraint	Lower Bound	Value	Upper Bound	Normalized Constraint	Show More Information
Search	Search	Search	Search	Search	Search	Search	Search	Search	
INITIAL	0	r1	VOLUME	-1.2516E-03	7.9900E+00 A	8.0000E+00	8.0100E+00 A	**-1.2484E-03****	
INITIAL	1	s0	FREQUENCY DISPLACEMENT		N/A	7.7146E-01	N/A		
INITIAL	1	s0	FREQUENCY DISPLACEMENT		N/A	7.8234E-01	N/A		
INITIAL	1	s0	FREQUENCY DISPLACEMENT		N/A	7.9405E-01	N/A		
INITIAL	1	s0	FREQUENCY DISPLACEMENT		N/A	8.0666E-01	N/A		
INITIAL	1	s0	FREQUENCY DISPLACEMENT		N/A	8.2023E-01	N/A		

Optimization Problem Statement

Design Variables

x1: T of PSHELL 1
x2: T of PSHELL 2
x3: T of PSHELL 3
x4: T of PSHELL 4
x5: T of PSHELL 5
x6: T of PSHELL 6
x7: T of PSHELL 7
x8: T of PSHELL 8
x9: T of PSHELL 9
x10 : T of PSHELL 10

.01 < xi < 1.0



Design Objective

S0: Minimize the root sum of squares for displacement magnitudes at node 1110 for forcing frequencies 20Hz - 200 Hz

$$min\phi = \sqrt{\sum_{i=20}^{200} (u^{i}_{z,\,1110})^2}$$

Design Constraints

r1: Volume

7.99 < r1 < 8.01

Contact me

- Nastran SOL 200 training
- Nastran SOL 200 questions
- Structural or mechanical optimization questions
- Access to the SOL 200 Web App

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Tutorial

SOL 200 Web App Capabilities

The Post-processor Web App and HDF5 Explorer are free to MSC Nastran users.

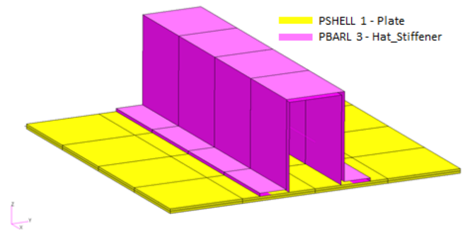
Compatibility

- Google Chrome, Mozilla Firefox or Microsoft Edge
- Windows and Red Hat Linux
- Installable on a company laptop, workstation or server. All data remains within your company.

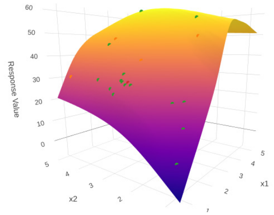
Benefits

- REAL TIME error detection. 200+ error validations.
- REALT TIME creation of bulk data entries.
- Web browser accessible
- Free Post-processor web apps
- +80 tutorials

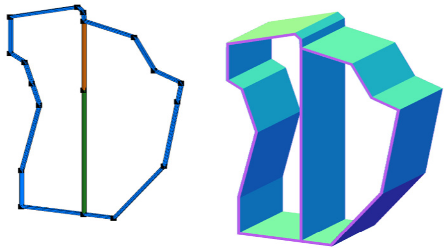
Web Apps



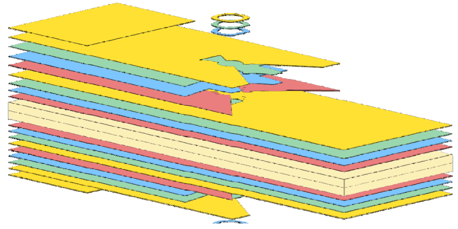
Web Apps for MSC Nastran SOL 200
Pre/post for MSC Nastran SOL 200. Support for size, topology, topometry, topography, multi-model optimization.



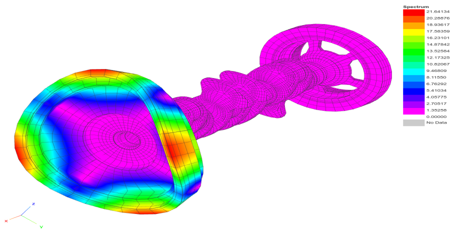
Machine Learning Web App
Bayesian Optimization for nonlinear response optimization (SOL 400)



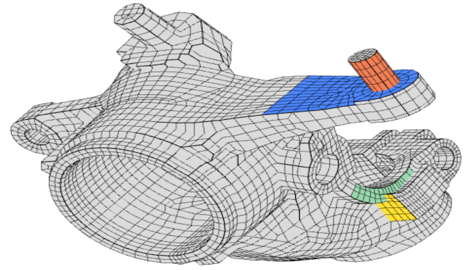
PBMSECT Web App
Generate PBMSECT and PBRSECT entries graphically



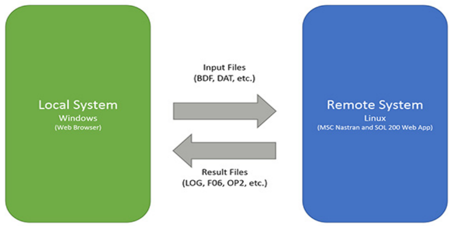
Ply Shape Optimization Web App
Optimize composite ply drop-off locations, and generate new PCOMPG entries



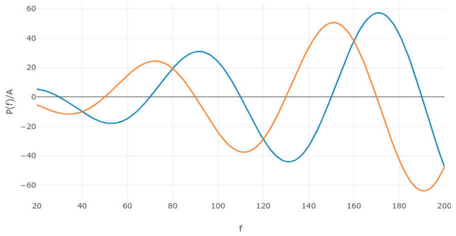
Post-processor Web App
View MSC Nastran results in a web browser on Windows and Linux



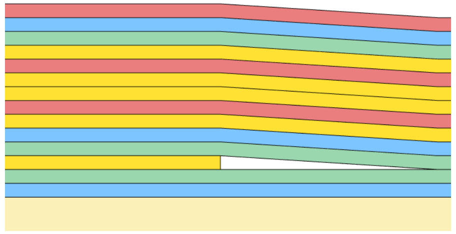
Shape Optimization Web App
Use a web application to configure and perform shape optimization.



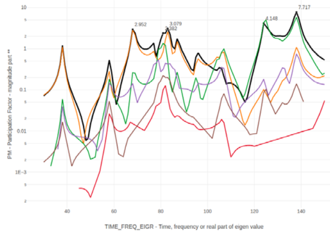
Remote Execution Web App
Run MSC Nastran jobs on remote Linux or Windows systems available on the local network



Dynamic Loads Web App
Generate RLOAD1, RLOAD2 and DLOAD entries graphically



Stacking Sequence Web App
Optimize the stacking sequence of composite laminate plies

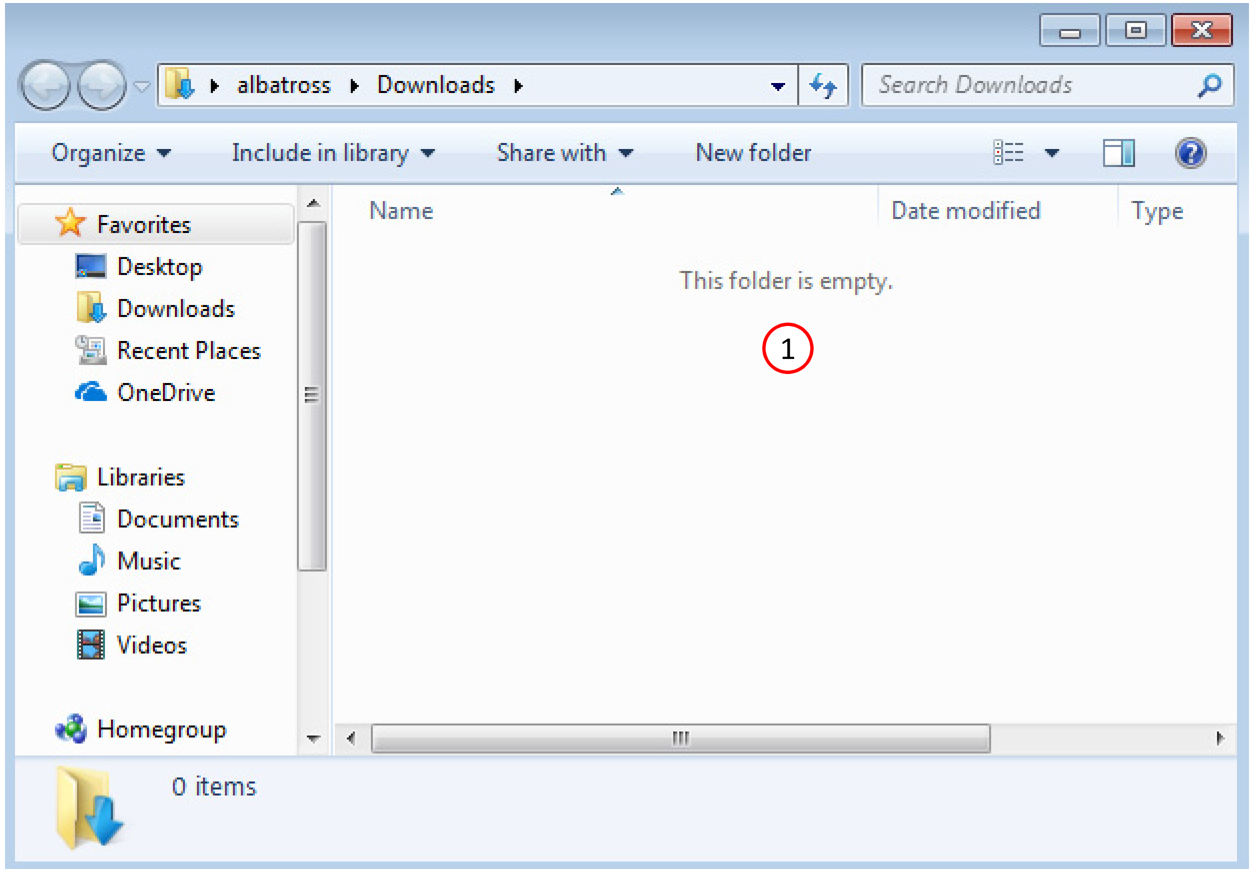


HDF5 Explorer Web App
Create graphs (XY plots) using data from the H5 file

Before Starting

1. Ensure the Downloads directory is empty in order to prevent confusion with other files

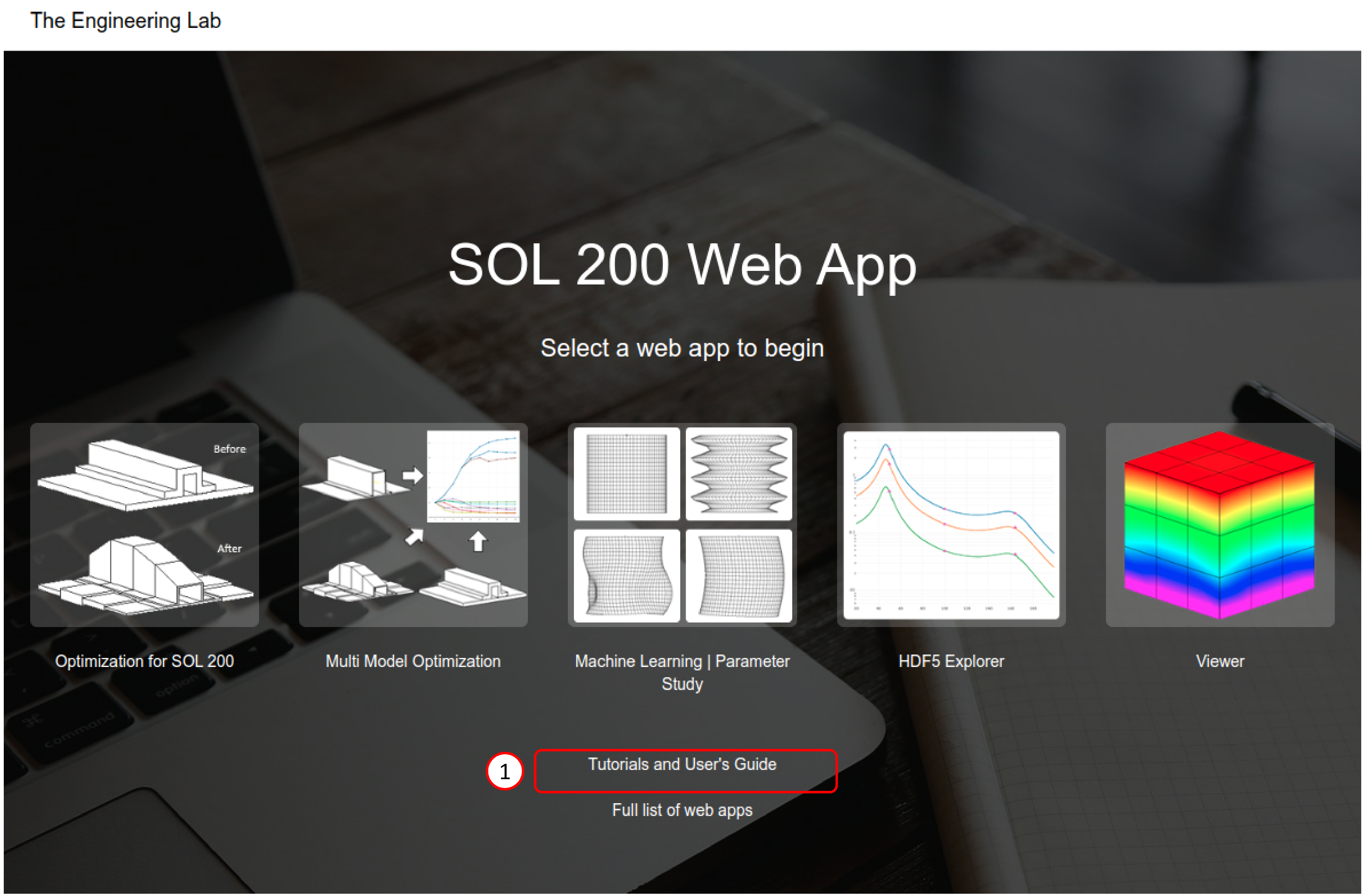
- Throughout this workshop, you will be working with multiple file types and directories such as:
  - .bdf/.dat
  - nastran_working_directory
  - .f06, .log, .pch, .h5, etc.
- To minimize confusion with files and folders, it is encouraged to start with a clean directory.



Go to the User’s Guide

1. Click on the indicated link

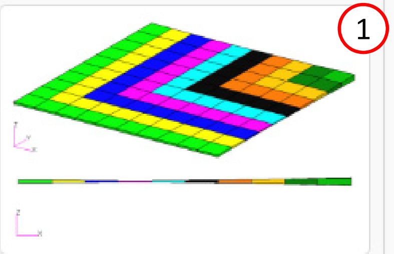
- The necessary BDF files for this tutorial are available in the Tutorials section of the User’s Guide.



Obtain Starting Files

1. Find the indicated example
2. Click Link
3. The starting file has been downloaded

- When starting the procedure, all the necessary BDF files must be collected together.


1

Dynamic Response Optimization with MSC Nastran Optimization

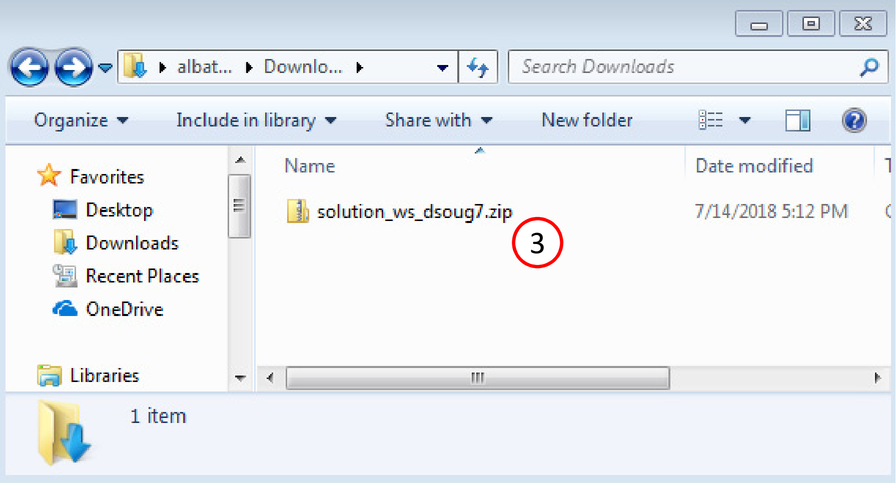
Link

This example is from the MSC Nastran Design Sensitivity and Optimization User's Guide.

> "This example demonstrates structural optimization when the structural loads are frequency dependent. The system considered is a flat rectangular plate clamped on three edges and free along the fourth, as shown in Figure 8-21 . The problem investigates minimization of the mean square response of the transverse displacement at the midpoint of the free edge, while constraining the volume of the structure (and hence, weight) to be equal to that of the initial design. A pressure loading with an amplitude of 1.0 lbf ⁄in^2 is applied across a frequency range of 20.0 to 200.0 Hz. A small amount of frequency- dependent modal damping has also been included."
>
> — *MSC Nastran 2016 Design Sensitivity and Optimization User's Guide. Chapter 8: Example Problems. Dynamic Response Optimization.*

Starting BDF Files: Link

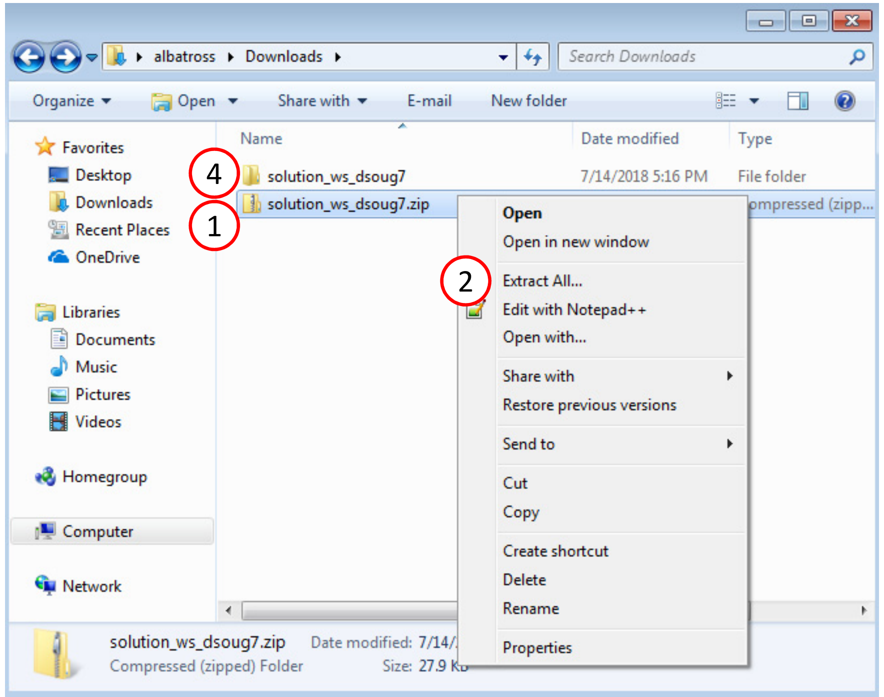
Solution BDF Files: Link 2

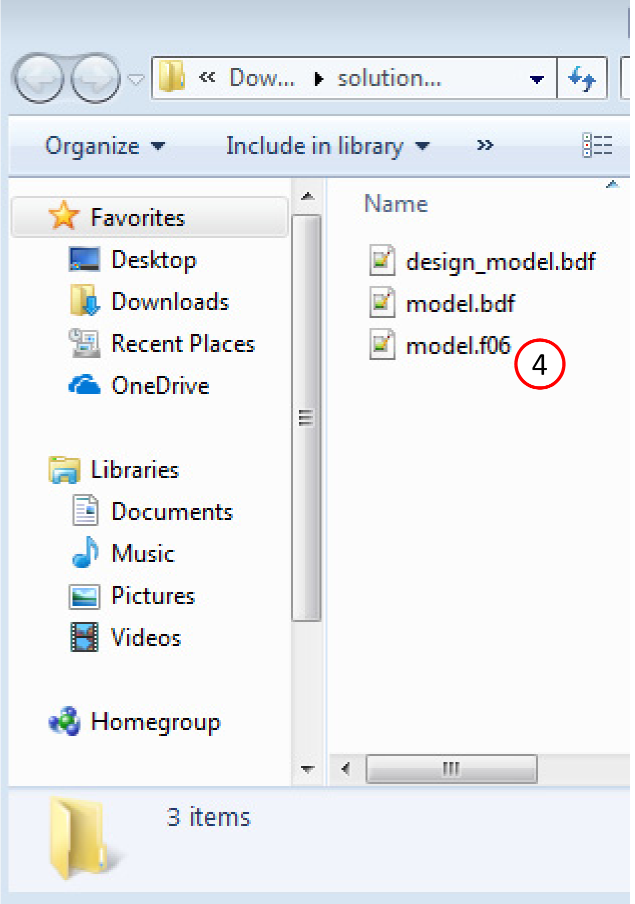


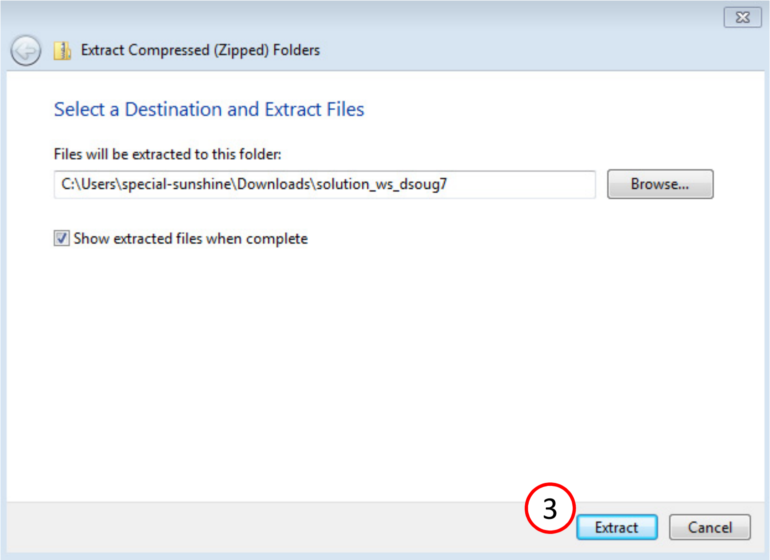
Obtain Starting Files

1. Right click on the zip file
2. Select Extract All…
3. Click Extract
4. The starting files are now available in a folder

- This example is using a previously created design model. The design model is a model that has been converted to SOL 200 and contains bulk data entries describing the optimization problem statement, e.g. variables, objective and constraints.







Open the Correct Page

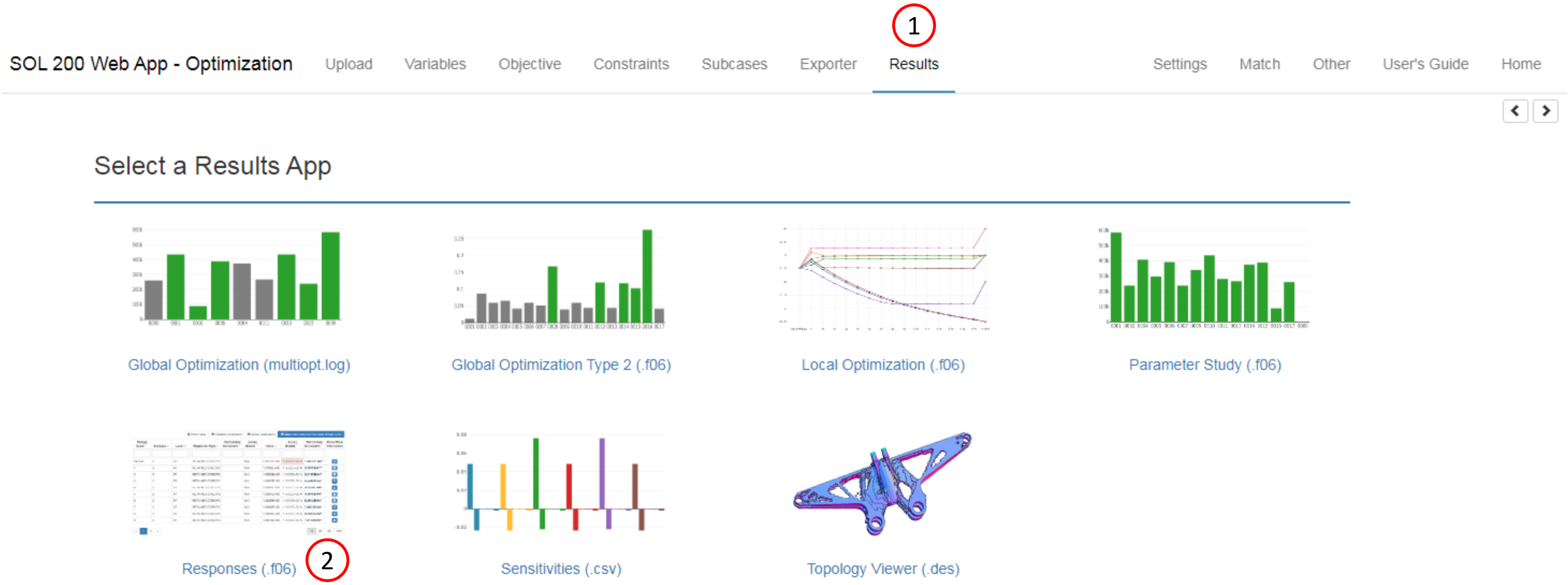
1. Click on the indicated link

- MSC Nastran can perform many optimization types. The SOL 200 Web App includes dedicated web apps for the following:
  - Optimization for SOL 200 (Size, Topology, Topometry, Topography, Local Optimization, Sensitivity Analysis and Global Optimization)
  - Multi Model Optimization
  - Machine Learning
- The web app also features the HDF5 Explorer, a web application to extract results from the H5 file type.

The Engineering Lab

Open the Responses App

1. Click Results.
2. Click Responses(.f06).



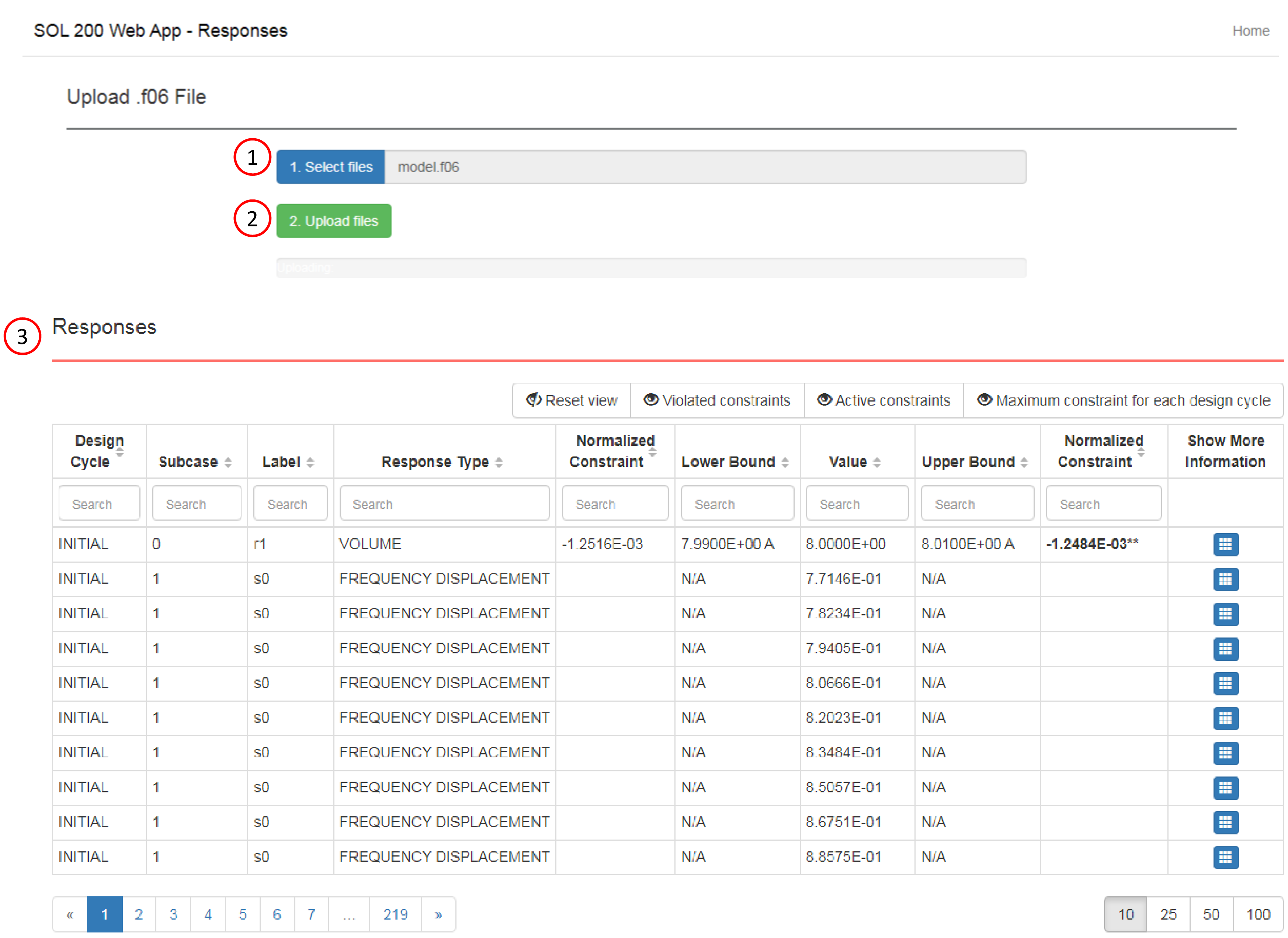
- The Results section contains links to numerous other web application designed for specific applications. For example, if sensitivity analysis is performed, the Sensitivities App can display the results.

Upload .f06

A new page is open to the Responses App.

1. Select the model.f06 file found in the folder.
2. Click Upload.
3. The responses found in the .f06 file are shown in the table.

- Once the F06 file is uploaded, the responses of each design cycle are available in the table. The table can be sorted and searched/filtered.
- In the F06 file and at each design cycle, there is a section titled “R E S P O N S E S I N D E S I G N M O D E L .” The responses from this section are the ones in the table shown in the Responses App.



Design Cycle	Subcase	Label	Response Type	Normalized Constraint	Lower Bound	Value	Upper Bound	Normalized Constraint	Show More Information
Search	Search	Search	Search	Search	Search	Search	Search	Search	
INITIAL	0	r1	VOLUME	-1.2516E-03	7.9900E+00 A	8.0000E+00	8.0100E+00 A	**-1.2484E-03****	
INITIAL	1	s0	FREQUENCY DISPLACEMENT		N/A	7.7146E-01	N/A		
INITIAL	1	s0	FREQUENCY DISPLACEMENT		N/A	7.8234E-01	N/A		
INITIAL	1	s0	FREQUENCY DISPLACEMENT		N/A	7.9405E-01	N/A		
INITIAL	1	s0	FREQUENCY DISPLACEMENT		N/A	8.0666E-01	N/A		
INITIAL	1	s0	FREQUENCY DISPLACEMENT		N/A	8.2023E-01	N/A		
INITIAL	1	s0	FREQUENCY DISPLACEMENT		N/A	8.3484E-01	N/A		
INITIAL	1	s0	FREQUENCY DISPLACEMENT		N/A	8.5057E-01	N/A		
INITIAL	1	s0	FREQUENCY DISPLACEMENT		N/A	8.6751E-01	N/A		
INITIAL	1	s0	FREQUENCY DISPLACEMENT		N/A	8.8575E-01	N/A		

Upload .f06

Before continuing, consider the following.

1. A section is found titled "DESIGN CONSTRAINTS ON RESPONSES." The reader may be tempted to consider the indicated value as the actual value of the constraint. This value is NOT the actual value of the constraint. The value shown is the normalized constraint for either the lower or upper bound of the constraint.
2. The actual value of the constraint or other responses is reported in the section RESPONSES IN DESIGN MODEL.

- As shown in the following pages, the Responses app organizes and displays this information in a single table.

----- DESIGN CONSTRAINTS ON RESPONSES -----

(MAXIMUM RESPONSE CONSTRAINTS MARKED WITH **)

INTERNAL ID	DCONSTR ID	INTERNAL RESPONSE ID	EXTERNAL DRESPx ID	RESPONSE TYPE	L/U FLAG	INTERNAL REGION ID	SUBCASE ID	VALUE
1	30002	2	8000002	STRESS	UPPER	1	1	-3.2350E-01**
2	30002	3	8000002	STRESS	LOWER	3	1	-3.9351E-01
3	30002	4	8000002	STRESS	LOWER	1	2	-3.9351E-01
4	30002	5	8000002	STRESS	UPPER	3	2	-3.2350E-01**

1

R E S P O N S E S IN D E S I G N M O D E L

(N/A - BOUND NOT ACTIVE OR AVAILABLE)
(*** VIOLATED RESPONSES MARKED WITH V ***)
(*** ACTIVE RESPONSES MARKED WITH A ***)

----- WEIGHT RESPONSE -----

INTERNAL ID	DRESP1 ID	RESPONSE LABEL	ROW ID	COLUMN ID	LOWER BOUND	VALUE	UPPER BOUND
1	8000000	R0	3	3	N/A	4.8284E+00	N/A

2

Upload .f06

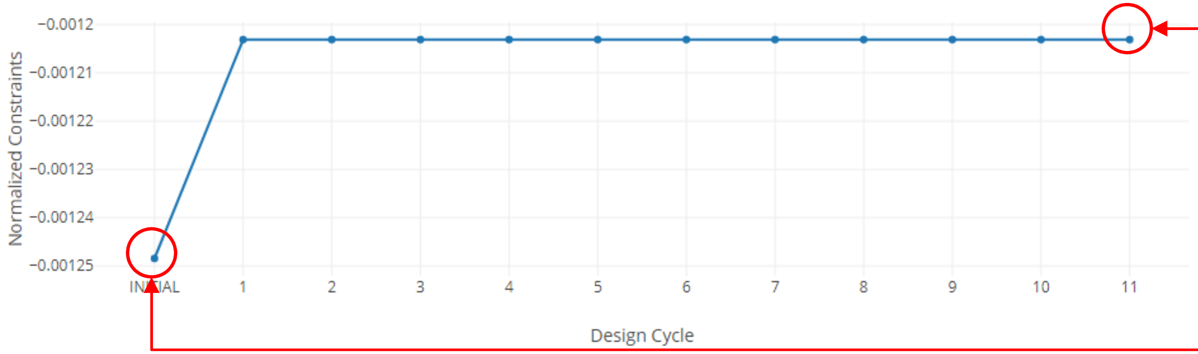
1. The Local Optimization Results App, a separate app, can be used to display the Normalized Constraints plot.
2. In the Response App, click Maximum constraint for each design cycle.
3. The table is updated. Each row represents a point in the Normalized Constraints plot.
4. Click 25 in the pagination bar to display additional rows in the table.

- Each design cycle has a leading constraint that is near or is violated. The Normalized Constraints plot shows the normalized constraint value of the leading constraint for each design cycle.
- For a more complicate design model, the leading constraint may vary for each design cycle, e.g. the leading constraint of design cycle 1 may be a displacement, but for the next cycle stress is the leading constraint.

1 SOL 200 Web App - Local Optimization Results

Normalized Constraints

+ Info



SOL 200 Web App - Responses

Home

Responses

2 3

Reset view | Violated constraints | Active constraints | Maximum constraint for each design cycle

Design Cycle	Subcase	Label	Response Type	Normalized Constraint	Lower Bound	Value	Upper Bound	Normalized Constraint	Show More Information
Search	Search	Search	Search	Search	Search	Search	Search	Search	
INITIAL	0	r1	VOLUME	-1.2516E-03	7.9900E+00 A	8.0000E+00	8.0100E+00 A	**-1.2484E-03****	
1	0	r1	VOLUME	**-1.2031E-03****	7.9900E+00 A	7.9996E+00	8.0100E+00 A	-1.2968E-03	
2	0	r1	VOLUME	**-1.2031E-03****	7.9900E+00 A	7.9996E+00	8.0100E+00 A	-1.2968E-03	
3	0	r1	VOLUME	**-1.2031E-03****	7.9900E+00 A	7.9996E+00	8.0100E+00 A	-1.2968E-03	
4	0	r1	VOLUME	**-1.2031E-03****	7.9900E+00 A	7.9996E+00	8.0100E+00 A	-1.2968E-03	
5	0	r1	VOLUME	**-1.2031E-03****	7.9900E+00 A	7.9996E+00	8.0100E+00 A	-1.2968E-03	
6	0	r1	VOLUME	**-1.2031E-03****	7.9900E+00 A	7.9996E+00	8.0100E+00 A	-1.2968E-03	
7	0	r1	VOLUME	**-1.2031E-03****	7.9900E+00 A	7.9996E+00	8.0100E+00 A	-1.2968E-03	
8	0	r1	VOLUME	**-1.2031E-03****	7.9900E+00 A	7.9996E+00	8.0100E+00 A	-1.2968E-03	
9	0	r1	VOLUME	**-1.2031E-03****	7.9900E+00 A	7.9996E+00	8.0100E+00 A	-1.2968E-03	
10	0	r1	VOLUME	**-1.2031E-03****	7.9900E+00 A	7.9996E+00	8.0100E+00 A	-1.2968E-03	
FINAL - 11	0	r1	VOLUME	**-1.2031E-03****	7.9900E+00 A	7.9996E+00	8.0100E+00 A	-1.2968E-03	

4

10 | 25 | 50 | 100

Normalized Constraints

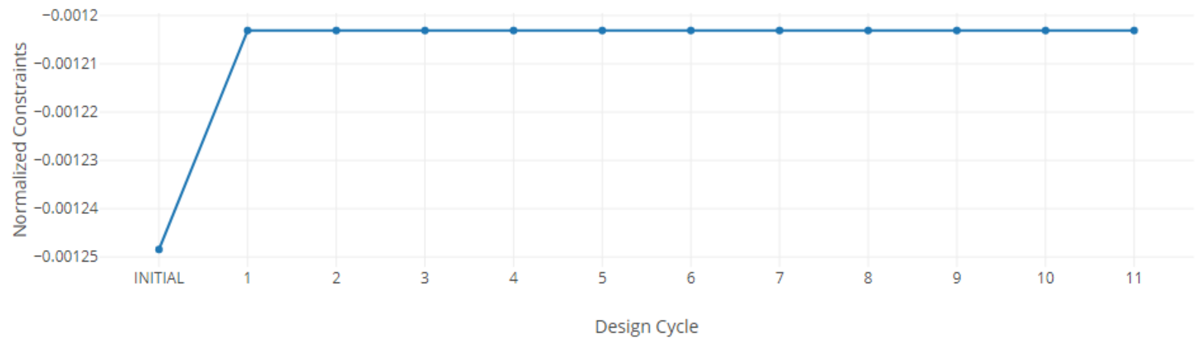
1. In this example, the Response Type of each row is Volume.
2. For the INITIAL design cycle, the volume is 8.
3. For Design Cycle 5, the volume is 7.99.

- The actual value of the response or constraint is reported in the Value column. Since the constraint has both a lower and upper bound, there are 2 normalized constraints, one for each bound.

SOL 200 Web App - Local Optimization Results

Normalized Constraints

+ Info



SOL 200 Web App - Responses

Home

Responses

1

Reset view | Violated constraints | Active constraints | Maximum constraint for each design cycle

Design Cycle	Subcase	Label	Response Type	Normalized Constraint	Lower Bound	Value	Upper Bound	Normalized Constraint	Show More Information
Search	Search	Search	Search	Search	Search	Se	Search	Search	
INITIAL	0	r1	VOLUME	-1.2516E-03	7.9900E+00 A	8.0000E+00	8.0100E+00 A	**-1.2484E-03****	
1	0	r1	VOLUME	**-1.2031E-03****	7.9900E+00 A	7.9996E+00	8.0100E+00 A	-1.2968E-03	
2	0	r1	VOLUME	**-1.2031E-03****	7.9900E+00 A	7.9996E+00	8.0100E+00 A	-1.2968E-03	
3	0	r1	VOLUME	**-1.2031E-03****	7.9900E+00 A	7.9996E+00	8.0100E+00 A	-1.2968E-03	
4	0	r1	VOLUME	**-1.2031E-03****	7.9900E+00 A	7.99[illegible]0	8.0100E+00 A	-1.2968E-03	
5	0	r1	VOLUME	**-1.2031E-03****	7.9900E+00 A	7.9996E+00	8.0100E+00 A	-1.2968E-03	
6	0	r1	VOLUME	**-1.2031E-03****	7.9900E+00 A	7.9996E+00	8.0100E+00 A	-1.2968E-03	
7	0	r1	VOLUME	**-1.2031E-03****	7.9900E+00 A	7.9996E+00	8.0100E+00 A	-1.2968E-03	
8	0	r1	VOLUME	**-1.2031E-03****	7.9900E+00 A	7.9996E+00	8.0100E+00 A	-1.2968E-03	
9	0	r1	VOLUME	**-1.2031E-03****	7.9900E+00 A	7.9996E+00	8.0100E+00 A	-1.2968E-03	
10	0	r1	VOLUME	**-1.2031E-03****	7.9900E+00 A	7.9996E+00	8.0100E+00 A	-1.2968E-03	
FINAL - 11	0	r1	VOLUME	**-1.2031E-03****	7.9900E+00 A	7.9996E+00	8.0100E+00 A	-1.2968E-03	

10 | 25 | 50 | 100

Show More Information

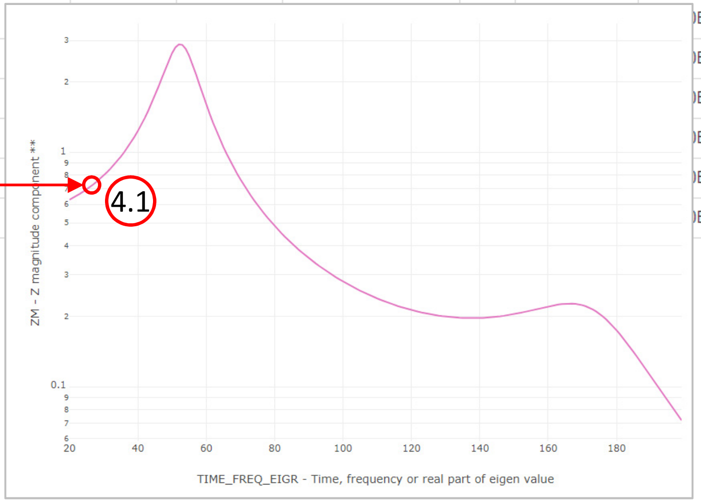
1. Click Reset view.
2. Type 6 as shown, this will filter the table so only responses from Design Cycle 6 are shown.
3. Click the Show More Information button and additional columns will be shown, e.g. GRID ID., COMPONENT NO., FREQUENCY.
4. The 7th row is read as follows: For GRID or node 1110, the 3rd component (z direction), at forcing frequency 25Hz, the displacement has a value of .6948.
    1. This single response represents a point on the XY plot at 25Hz.

- Note that a single label, e.g. s0, can be associated with multiple responses. For example, s0 represents 180 frequency displacement values, one for each forcing frequency and there are 180 forcing frequencies.

Responses

Reset view | Violated constraints | Active constraints | Maximum constraint for each design cycle

Design Cycle	Subcase	Label	Response Type	Normalized Constraint	Lower Bound	Value	Upper Bound	Normalized Constraint	Show More Information	designCycleNumber	GRID ID	COMPONENT NO.	FREQUENCY
6	Searc	Se	Search	Search	Search	Search	Search	Search					
6	0	r1	VOLUME	**-1.2031E-03****	7.9900E+00 A	7.9996E+00	8.0100E+00 A	-1.2968E-03		6			
6	1	s0	FREQUENCY DISPLACEMENT		N/A	6.2789E-01	N/A			6	1110	3	2.0000E+01
6	1	s0	FREQUENCY DISPLACEMENT		N/A	6.3920E-01	N/A			6	1110	3	2.1000E+01
6	1	s0	FREQUENCY DISPLACEMENT		N/A	6.5146E-01	N/A			6	1110	3	2.2000E+01
6	1	s0	FREQUENCY DISPLACEMENT		N/A	6.6477E-01	N/A			6	1110	3	2.3000E+01
6	1	s0	FREQUENCY DISPLACEMENT		N/A	6.7921E-01	N/A			6	1110	3	2.4000E+01
6	1	s0	FREQUENCY DISPLACEMENT		N/A	6.9488E-01	N/A			6	1110	3	2.5000E+01
6	1	s0	FREQUENCY DISPLACEMENT		N/A	7.1192E-01	N/A			6	1110	3	2.6000E+01
6	1	s0	FREQUENCY DISPLACEMENT		N/A	7.3045E-01	N/A			6	1110	3	2.7000E+01
6	1	s0	FREQUENCY DISPLACEMENT		N/A	7.5064E-01	N/A			6	1110	3	2.8000E+01
6	1	s0	FREQUENCY DISPLACEMENT		N/A	7.7266E-01	N/A			6	1110	3	2.9000E+01
6	1	s0	FREQUENCY DISPLACEMENT		N/A	7.9672E-01	N/A			6	1110	3	3.0000E+01
6	1	s0	FREQUENCY DISPLACEMENT		N/A	8.2308E-01	N/A			6	1110	3	3.1000E+01
6	1	s0	FREQUENCY DISPLACEMENT		N/A	8.5201E-01	N/A						E+01
6	1	s0	FREQUENCY DISPLACEMENT		N/A	8.8385E-01	N/A						E+01
6	1	s0	FREQUENCY DISPLACEMENT		N/A	9.1900E-01	N/A						E+01
6	1	s0	FREQUENCY DISPLACEMENT		N/A	9.5791E-01	N/A						E+01
6	1	s0	FREQUENCY DISPLACEMENT		N/A	1.0011E+00	N/A						E+01
6	1	s0	FREQUENCY DISPLACEMENT		N/A	1.0494E+00	N/A						E+01



Labels

1. Note that in the separate Optimization web app the objective was set to minimize S0 or the Root Sum of Squares (RSS) for all the displacements of GRID or node 1110, 3rd component (z direction), across all the forcing frequencies.
2. The lowercase of label S0 is shown in the Responses App.

- The capitalization of the label matters in the web app. In the Size app, the label is <u>S</u>0, where the letter s is upper case. The Responses app displays s0, where the letter s is lower case. The RSS option was used for S0, so all the s0 values are used to compute the RSS value.

SOL 200 Web App - Size | Variables | Objective | Constraints | Subcases | Exporter | Results

Step 2 - Adjust objective

+ Options

	Label	Status	Response Type	Maximize or Minimize	Property Type	ATTA	ATTB	ATTi
✖	S0	✔	FRDISP	MIN		3 - RM - T3 (Rectangular z, Cylindr	RSS - Root Su	1110

1

Responses

Reset view | Violated constraints | Active constraints | Maximum constraint for each design cycle

Design Cycle	Subcase	Label	Response Type	Normalized Constraint	Lower Bound	Value	Upper Bound	Normalized Constraint	Show More Information	designCycleNumber	GRID ID	COMPONENT NO.	FREQUENCY
6	Searc	S	Search	Search	Search	Search	Search	Search					
6	0	r1	VOLUME	**-1.2031E-03****	7.9900E+00 A	7.9996E+00	8.0100E+00 A	-1.2968E-03		6			
6	1	s0	FREQUENCY DISPLACEMENT		N/A	6.2789E-01	N/A			6	1110	3	2.0000E+01
6	1	s0	FREQUENCY DISPLACEMENT		N/A	6.3920E-01	N/A			6	1110	3	2.1000E+01
6	1	s0	FREQUENCY DISPLACEMENT		N/A	6.5146E-01	N/A			6	1110	3	2.2000E+01
6	1	s0	FREQUENCY DISPLACEMENT		N/A	6.6477E-01	N/A			6	1110	3	2.3000E+01
6	1	s0	FREQUENCY DISPLACEMENT		N/A	6.7921E-01	N/A			6	1110	3	2.4000E+01
6	1	s0	FREQUENCY DISPLACEMENT		N/A	6.9488E-01	N/A			6	1110	3	2.5000E+01
6	1	s0	FREQUENCY DISPLACEMENT		N/A	7.1192E-01	N/A			6	1110	3	2.6000E+01
6	1	s0	FREQUENCY DISPLACEMENT		N/A	7.3045E-01	N/A			6	1110	3	2.7000E+01
6	1	s0	FREQUENCY DISPLACEMENT		N/A	7.5064E-01	N/A			6	1110	3	2.8000E+01
6	1	s0	FREQUENCY DISPLACEMENT		N/A	7.7266E-01	N/A			6	1110	3	2.9000E+01
6	1	s0	FREQUENCY DISPLACEMENT		N/A	7.9672E-01	N/A			6	1110	3	3.0000E+01
6	1	s0	FREQUENCY DISPLACEMENT		N/A	8.2308E-01	N/A			6	1110	3	3.1000E+01
6	1	s0	FREQUENCY DISPLACEMENT		N/A	8.5201E-01	N/A			6	1110	3	3.2000E+01
6	1	s0	FREQUENCY DISPLACEMENT		N/A	8.8385E-01	N/A			6	1110	3	3.3000E+01
6	1	s0	FREQUENCY DISPLACEMENT		N/A	9.1900E-01	N/A			6	1110	3	3.4000E+01

2

Labels

MSC Nastran computes the value of S0 as follows:

1. For each forcing frequency, determine the corresponding displacement value. Each of these values are be labeled ‘s0.’
2. Take all the displacement values s0 and compute the Root Sum of Squares S0. Note the difference in capitalization. To view the S0 value
    1. Click 10 in the pagination bar to display at most 10 rows.
    2. Navigate to page 19.
    3. The RSS value is reported as 11.558.

- When looking through the table, the final RSS value for S0 is found.

Responses

Reset view | Violated constraints | Active constraints | Maximum constraint for each design cycle

Design Cycle	Subcase	Label	Response Type	Normalized Constraint	Lower Bound	Value	Upper Bound	Normalized Constraint	Show More Information	designCycleNumber	GRID ID	COMPONENT NO.	FREQUENCY
6	Searc	Se	Search	Search	Search	Search	Search	Search					
6	0	r1	VOLUME	-1.2031E-03**	7.9900E+00 A	7.9996E+00	8.0100E+00 A	-1.2968E-03		6			
6	1	s0	FREQUENCY DISPLACEMENT		N/A	6.2789E-01	N/A			6	1110	3	2.0000E+01
6	1	s0	FREQUENCY DISPLACEMENT		N/A	6.3920E-01	N/A			6	1110	3	2.1000E+01
6	1	s0	FREQUENCY DISPLACEMENT		N/A	6.5146E-01	N/A			6	1110	3	2.2000E+01
6	1	s0	FREQUENCY DISPLACEMENT		N/A	6.6477E-01	N/A			6	1110	3	2.3000E+01
6	1	s0	FREQUENCY DISPLACEMENT		N/A	6.7921E-01	N/A			6	1110	3	2.4000E+01
6	1	s0	FREQUENCY DISPLACEMENT		N/A	6.9488E-01	N/A			6	1110	3	2.5000E+01
6	1	s0	FREQUENCY DISPLACEMENT		N/A	7.1192E-01	N/A			6	1110	3	2.6000E+01
6	1	s0	FREQUENCY DISPLACEMENT		N/A	7.3045E-01	N/A			6	1110	3	2.7000E+01
6	1	s0	FREQUENCY DISPLACEMENT		N/A	7.5064E-01	N/A			6	1110	3	2.8000E+01
6	1	s0	FREQUENCY DISPLACEMENT		N/A	7.7266E-01	N/A			6	1110	3	2.9000E+01
6	1	s0	FREQUENCY DISPLACEMENT		N/A	7.9672E-01	N/A			6	1110	3	3.0000E+01
6	1	s0	FREQUENCY DISPLACEMENT		N/A	8.2308E-01	N/A			6	1110	3	3.1000E+01
6	1	s0	FREQUENCY DISPLACEMENT		N/A	8.5201E-01	N/A			6	1110	3	3.2000E+01
6	1	s0	FREQUENCY DISPLACEMENT		N/A	8.8385E-01	N/A			6	1110	3	3.3000E+01
6	1	s0	FREQUENCY DISPLACEMENT		N/A	9.1900E-01	N/A			6	1110	3	3.4000E+01

1

« 1 2 3 4 5 6 7 8 »

10 25 50 100

Responses

Reset view | Violated constraints | Active constraints | Maximum constraint for each design cycle

Design Cycle	Subcase	Label	Response Type	Normalized Constraint	Lower Bound	Value	Upper Bound	Normalized Constraint	Show More Information	designCycleNumber	GRID ID	COMPONENT NO.	FREQUENCY
6	Searc	Se	Search	Search	Sea	Search	Sea	Search					
6	1	s0	FREQUENCY DISPLACEMENT		N/A	7.1904E-02	N/A			6	1110	3	1.9900E+02
6	0	S0	RETAINED DRESP2		N/A	1.1558E+01	N/A			6			

« 1 ... 13 14 15 16 17 18 19 »

2.3

10 25 50 100

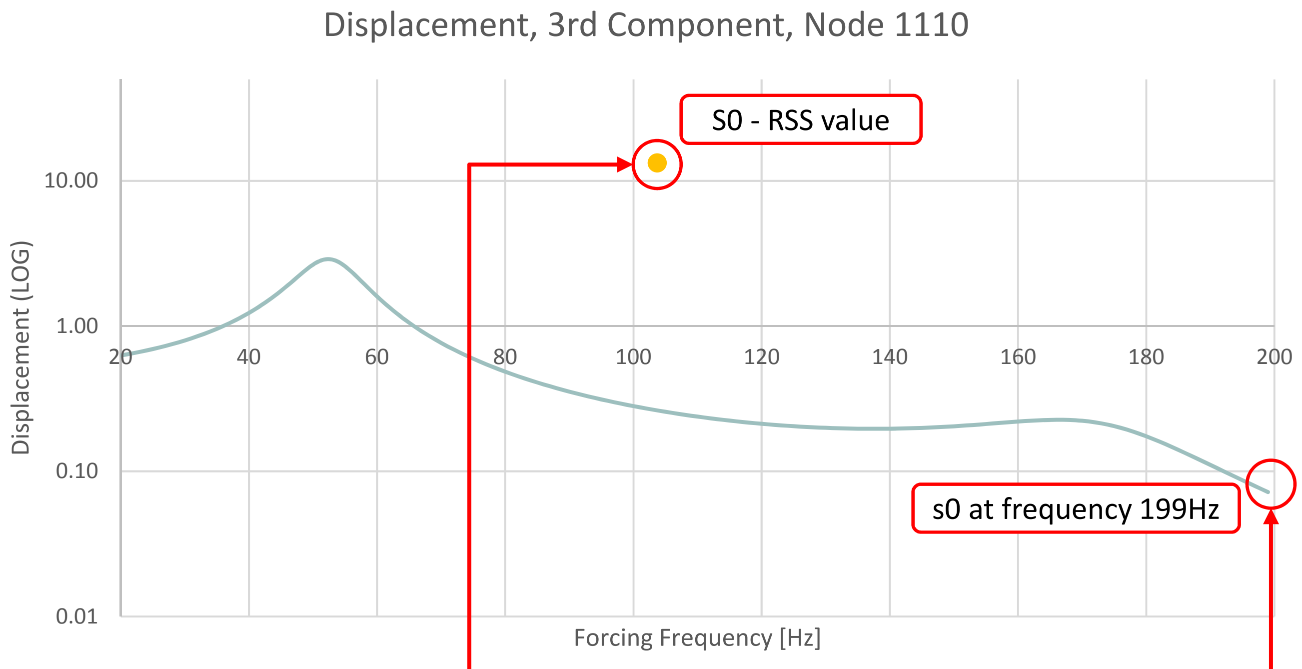
2.2

2.1

Labels

1. A plot of the displacement vs forcing frequencies and the corresponding RSS value is shown to better communicate the point made on the previous slide.

- A separate HDF5 Explorer that comes with the SOL 200 Web App is capable of creating the frequency response XY plots. A CSV file was exported and the RSS value S0 was super imposed on the XY plot.



Responses

Reset view | Violated constraints | Active constraints | Maximum constraint for each design cycle

Design Cycle	Subcase	Label	Response Type	Normalized Constraint	Lower Bound	Value	Upper Bound	Normalized Constraint	Show More Information	designCycleNumber	GRID ID	COMPONENT NO.	FREQUENCY
6	1	s0	FREQUENCY DISPLACEMENT		N/A	7.1904E-02	N/A			6	1110	3	1.9900E+02
6	0	S0	RETAINED DRESP2		N/A	1.1558E+01	N/A			6			

« 1 … 13 14 15 16 17 18 19 »

10 25 50 100

Approximate Model or FEA

Each design cycle produces two sets of results:

- Results from the Approximate Model
- Results from the FEA.

While the F06 file reports responses from the Approximate Model and FEA, the Responses web app never reports responses from only FEA.

A look at the .f06 file and for Design Cycle 3 shows two columns: INPUT VALUE and OUTPUT VALUE.

1. INPUT VALUE is the FEA value based on the design of the previous design cycle, in this case design cycle 2. This value is reported in the Responses App and is tagged as originating from design cycle 2.
2. OUTPUT VALUE is the approximate value from the current design cycle. This value is never reported in the Responses App.

Note that the INITIAL and FINAL design cycles only have one VALUE column. These values are reported as is by the Responses App.

```
D E S I G N    O P T I M I Z A T I O N

D E S I G N   C Y C L E      3

*****   OPTIMIZATION RESULTS BASED ON THE APPROXIMATE MODEL   *****

|      R E S P O N S E S    IN    D E S I G N    M O D E L      |

(N/A - BOUND NOT ACTIVE OR AVAILABLE)
(*** VIOLATED RESPONSES MARKED WITH V ***)
(*** ACTIVE RESPONSES MARKED WITH A ***)

-----    VOLUME RESPONSE    -----
```

INTERNAL ID	DRESP1 ID	RESPONSE LABEL	LOWER BOUND	INPUT VALUE	OUTPUT VALUE	UPPER BOUND
1	8000001	R1	7.9900E+00 A	7.9996E+00	7.9996E+00	8.0100E+00 A

D E S I G N   C Y C L E =   3   S U B C A S E =   1

-----   FREQUENCY DISPLACEMENT RESPONSES   -----

INTERNAL ID	DRESP1 ID	RESPONSE LABEL	GRID ID	COMPONENT NO.	FREQUENCY	LOWER BOUND	1 INPUT VALUE	2 OUTPUT VALUE	UPPER BOUND
2	8000000	S0	1110	3	2.0000E+01	N/A	6.3462E-01	6.2809E-01	N/A
3	8000000	S0	1110	3	2.1000E+01	N/A	6.4481E-01	6.3853E-01	N/A
4	8000000	S0	1110	3	2.2000E+01	N/A	6.5583E-01	6.4982E-01	N/A
5	8000000	S0	1110	3	2.3000E+01	N/A	6.6774E-01	6.6203E-01	N/A
6	8000000	S0	1110	3	2.4000E+01	N/A	6.8061E-01	6.7524E-01	N/A
7	8000000	S0	1110	3	2.5000E+01	N/A	6.9451E-01	6.8954E-01	N/A
8	8000000	S0	1110	3	2.6000E+01	N/A	7.0955E-01	7.0502E-01	N/A
9	8000000	S0	1110	3	2.7000E+01	N/A	7.2582E-01	7.2180E-01	N/A
10	8000000	S0	1110	3	2.8000E+01	N/A	7.4345E-01	7.4000E-01	N/A
11	8000000	S0	1110	3	2.9000E+01	N/A	7.6255E-01	7.5976E-01	N/A
12	8000000	S0	1110	3	3.0000E+01	N/A	7.8330E-01	7.8126E-01	N/A

Another Example

The title of this example is ‘Automated Structural Optimization of a Stiffened Plate with MSC Nastran SOL 200/Design Optimization’ and can be found in the Tutorials section of the User’s Guide.

1. Like before, download the solution files, extract the .f06 file, upload the file to the Responses App and click Maximum constraint for each design cycle.
2. Click on the Show More Information button.
3. In the Responses Web App, for r3 and for design cycle 3, the New Design has a von Mises stress of 25133 PSI for element 3 is and is violating its upper bound of 25000 PSI.
4. In the Optimization web app, for r3, the response type is STRESS, the component is 9 - von Mises of z1, and has an upper bound of 25000. This is similar to what is shown in the Optimization web app. Note that ATTi is 1 which indicates r3 applies to any element associated to PSHELL ID 1.

- The label r3 when configured corresponds to the von Mises stress of any element associated with PSHELL 1. Since PSHELL 1 has 16 elements associated, r3 corresponds to 16 von Mises stress values.
- When viewing r3 in the Responses app, use the Show More Information button to display the ELEMENT ID column. This makes differentiating the responses simpler.

SOL 200 Web App - Optimization | Upload | Variables | Objective | Constraints | Subcases | Exporter | Results

Constraints | Equation Constraints

Step 2 - Adjust constraints

+ Options

	Label	Status	Response Type	Property Type	ATTA	ATTB	ATTi	Lower Allowed Limit	Upper Allowed Limit
	Se	Sea	Search	Search	Search	Search	Search	Search	Search
✖	r1	✔	STRESS	PBARL	7 - End A maximum		3	-25000.	25000.
✖	r2	✔	STRESS	PBARL	14 - End B maximum		3	-25000.	25000.
✖	r3	✔	STRESS	PSHELL	9 - von Mises or maximum shear a		1	Lower	25000.
✖	r4	✔	STRESS	PSHELL	17 - von Mises or maximum shear		1	Lower	25000.
✖	r5	✔	DISP		3 - T3 (Rectangular z, Cylindrical z		10302	-.1	.1
✖	r6	✔	DISP		3 - T3 (Rectangular z, Cylindrical z		10203	-.03	.03

SOL 200 Web App - Responses | Home

Responses

Reset view | Violated constraints | Active constraints | Maximum constraint for each design cycle

Design Cycle	Subcase	Label	Response Type	Normalized Constraint	Lower Bound	Value	Upper Bound	Normalized Constraint	Show More Information	designCycleNumber	ELEMENT ID	COMPONENT NO.
Search	Search	Se	Search	Search	Sea	Search	Search	Search				
INITIAL	2	r1	STRESS		N/A	2.0902E+04	2.5000E+04	**-1.6392E-01****		0	34	7
1	1	r5	DISPLACEMENT		N/A	1.6545E-01	1.0000E-01 V	**6.5446E-01****		1		3
2	1	r3	STRESS		N/A	2.7165E+04	2.5000E+04 V	**8.6588E-02****		2	15	9
3	1	r3	STRESS		N/A	2.5133E+04	2.5000E+04 V	**5.3229E-03****		3	3	9
4	1	r3	STRESS		N/A	2.5001E+04	2.5000E+04 A	**2.4418E-05****		4	3	9
FINAL - 5	1	r3	STRESS		N/A	2.5001E+04	2.5000E+04 A	**2.4418E-05****		5	3	9

Another Example

1. Note that r3 appears multiple times.

2. The element column reveals that r3 is associated with different elements. According to the ELEMENT ID column, elements 15 and 3 are associated with r3.

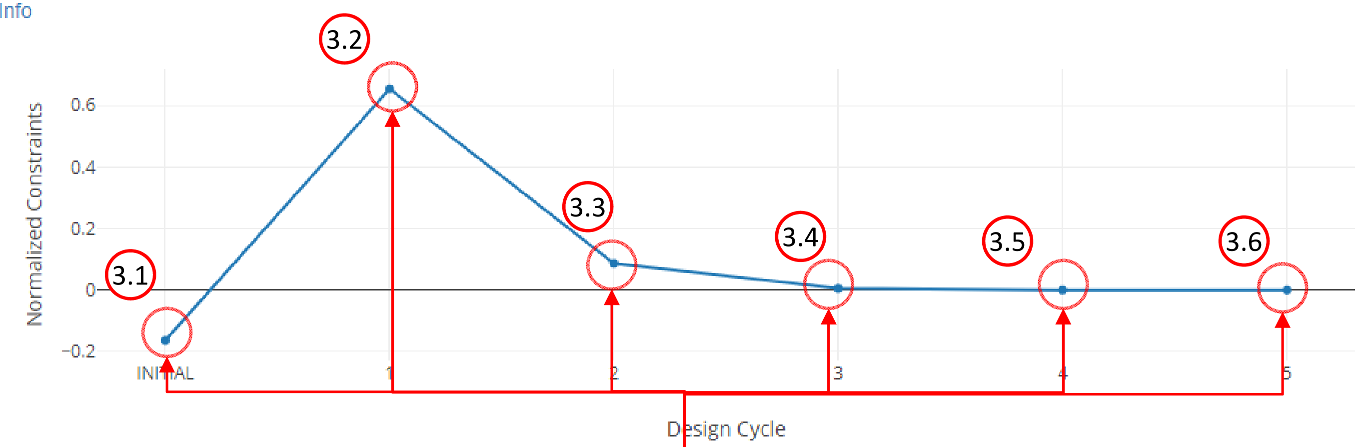
3. Each design cycle can have a different constraint that is controlling or the limiting factor in the design cycle. Below is a summary of these constraints. The Normalized Constraints plot is also shown.
   1. INITIAL Design - The maximum stress of the beam cross section (Component 7) of element 34. Value: 20902 PSI. Constraint satisfied.
   2. Design Cycle 1 - The displacement, 3 or z component, of node 10302 (not shown). Value: .0165 inches. Constraint violated.
   3. Design Cycle 2 - The von Mises stress of z1 (Component 9) of element 15. Value: 27165 PSI. Constraint violated.
   4. Design Cycle 3 - The von Mises stress of z1 (Component 9) of element 15. Value: 25133 PSI. Constraint violated.
   5. Design Cycle 4 - The von Mises stress of z1 (Component 9) of element 15. Value: 25001 PSI. Constraint satisfied.
   6. Design Cycle 5 (FINAL) - The von Mises stress of z1 (Component 9) of element 15. Value: 25001 PSI. Constraint satisfied.

- A design is feasible if the max normalized constraint is less than GMAX.
- GMAX has a default value of 0.005 and may be changed via the DOPTPRM entry.
- Designs from cycles INITIAL, 4 and 5 are feasible.

SOL 200 Web App - Local Optimization Results

Normalized Constraints

+ Info



SOL 200 Web App - Responses

Home

Responses

Reset view | Violated constraints | Active constraints | Maximum constraint for each design cycle

Design Cycle	Subcase	Label	Response Type	Normalized Constraint	Lower Bound	Value	Upper Bound	Normalized Constraint	Show More Information	designCycleNumber	ELEMENT ID	COMPONENT NO.
Search	Search	Se	Search	Search	Sea	Search	Search	Search				
INITIAL	2	r1	STRESS		N/A	2.0902E+04	2.5000E+04	**-1.6392E-01****		0	34	7
1	1	r5	DISPLACEMENT		N/A	1.6545E-01	1.0000E-01 V	**6.5446E-01****		1		3
2	1	r3	STRESS		N/A	2.7165E+04	2.5000E+04 V	**8.6588E-02****		2	15	9
3	1	r3	STRESS		N/A	2.5133E+04	2.5000E+04 V	**5.3229E-03****		3	3	9
4	1	r3	STRESS		N/A	2.5001E+04	2.5000E+04 A	**2.4418E-05****		4	3	9
FINAL - 5	1	r3	STRESS		N/A	2.5001E+04	2.5000E+04 A	**2.4418E-05****		5	3	9

1

2

End of Tutorial