**Table 4 A detailed list of a typical GENOPT/BIGBOSOR4 run stream**

=========================================================================

balloon.runstream

October 23 – November 3, 2010

Please read the file, /home/progs/genopt/doc/getting.started.

Please read the paper, /home/progs/genopt/case/balloon/balloon.paper.pdf:

[1] Bushnell, David, "Use of GENOPT and BIGBOSOR4 to obtain optimum

designs of double-walled inflatable cylindrical vacuum chambers",

unpublished report, November, 2010.

Figure numbers and table numbers referenced below are from this report,

called "Ref.[1]" or simply "[1]" in the following text. Note that

Tables 3 - 18 are located in the APPENDIX of [1].

NOTE: It is assumed here that the home directory is "/home/progs".

Commands typed by the GENOPT user and the end user are in

**bold face**.

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* **PART 1** \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

TASKS PERFORMED BY **THE GENOPT USER**

First, the GENOPT user must establish the program system by means

of which optimum designs in the generic class called "balloon"

can be found.

------------------ begin GENOPT user's activities ------------------

COMMAND MEANING OF COMMAND

**cd /home/progs/genoptcase** (go to "genoptcase")

**genoptlog** (activate the GENOPT set of commands)

**gentext** (provide input for GENTEXT: balloon.INP .

If you already have a complete file, balloon.INP,

then:

cp /home/progs/genopt/case/balloon/balloon.INP

/home/progs/genoptcase/balloon.INP

balloon.INP = Table 3 in the appendix of [1])

**insert** (add other variables you may have forgotten

during the initial execution of GENTEXT.

Remember first to save any valuable new

coding that may exist in behavior.new and/or

struct.new, as these two files are destroyed

by re-execution of GENTEXT.)

See Table 1 in [1] for a glossary of variables created by the

GENOPT user. Table 1 appears as part of the file, balloon.DEF,

in /home/progs/genoptcase. This file is created automatically

by GENTEXT.

See Table 2 in [1] for a complete list of the file, balloon.PRO,

in /home/progs/genoptcase. This file is created automatically

by GENTEXT. It is the file with the input data prompting

phrases and "help" paragraphs that will be seen by the end user.

Next:

1. "flesh out" the skeletal SUBROUTINES BEHX1, BEHX2, BEHX3

BEHX4, and OBJECT. See the file:

/home/progs/genopt/case/balloon/behavior.balloon

and, if such a file exists in your archive, type:

cp /home/progs/genopt/case/balloon/behavior.balloon

/home/progs/genoptcase/behavior.balloon

behavior.balloon = Table 5 in the appendix of [1].

2. add the three statements, CALL OPNGEN, CALL RWDGEN, and

call CLSGEN at the appropriate places in the skeletal

SUBROUTINE STRUCT, See the file:

/home/progs/genopt/case/balloon/struct.balloon

and, if such a file exists in your archive, type:

cp /home/progs/genopt/case/balloon/struct.balloon

/home/progs/genoptcase/struct.balloon

struct.balloon = Table 6 in the appendix of [1].

3. Create SUBROUTINE BOSDEC. In this case there are two versions:

a. bosdec.balloon = balloon with "truss" (slanted) webs

(Fig.2 of [1]). See the file:

/home/progs/genopt/case/balloon/bosdec.balloon

and, if such a file exists in your archive, type:

cp /home/progs/genopt/case/balloon/bosdec.balloon

/home/progs/bosdec/sources/bosdec.balloon).

bosdec.balloon = Table 7 in the appendix of [1].

b. bosdec.balloon2 = balloon with radially oriented webs

(Fig. 1 of [1]). See the file:

/home/progs/genopt/case/balloon/bosdec.balloon2

and, if such a file exists in your archive, type:

cp /home/progs/genopt/case/balloon/bosdec.balloon2

/home/progs/bosdec/sources/bosdec.balloon2

bosdec.balloon2 = no table included in [1] for this file.

It is very like bosdec.balloon (Table 7)

COMMAND MEANING OF COMMAND

**cd /home/progs/bosdec/sources** (go to directory where "bosdec" exists)

**cp bosdec.balloon bosdec.src**

or

**cp bosdec.balloon2 bosdec.src**

**cd /home/progs/genoptcase** (return to "genoptcase" directory)

and, if appropriate:

**cp behavior.balloon behavior.new** (store "fleshed out" "behavior")

**cp struct.balloon struct.new** (store "fleshed out" "struct")

**genprograms** (compiles the GENOPT program system for the

generic case called "balloon")

Next:

1. Correct any FORTRAN errors in SUBROUTINE BOSDEC (bosdec.src)

2. Correct any FORTRAN errors in SUBROUTINES BEHX1, BEHX2, BEHX3,

BEHX4, OBJECT (behavior.new)

3. Store the updated FORTRAN code as follows:

cp /home/progs/bosdec/sources/bosdec.src

/home/progs/bosdec/sources/bosdec.balloon or bosdec.balloon2

whichever version of SUBROUTINE BOSDEC you are working on.

cp /home/progs/genoptcase/behavior.new

/home/progs/genoptcase/behavior.balloon

Make sure before you do these "cp" that the versions of

bosdec.src and behavior.new are really the ones you want

to use to update bosdec.balloon (or bosdec.balloon2) and

behavior.balloon. You don't want erroneously to overwrite

your archive files that you have worked so hard on!

COMMAND MEANING OF COMMAND

**genprograms** (re-compiles the GENOPT program system for the

generic case called "balloon")

Next, correct any logical errors or other mistakes in

SUBROUTINE BOSDEC or in SUBROUTINES BEHX1, BEHX2, BEHX3,

BEHX4, OBJECT and again save the updated FORTRAN code as above.

**genprograms** (re-compiles the GENOPT program system for the

generic case called "balloon")

Keep correcting bosdec.src, behavior.new and recompiling via

the "genprograms" command until you are satisfied that everything

is correct. You will usually have to execute BEGIN, DECIDE,

MAINSETUP, OPTIMIZE as described next in order to complete your

modifications of bosdec.src and behavior.new. Each time through

the "modification loop" make sure to save archive versions of

bosdec.src and behavior.new (here called "bosdec.balloon" and

"behavior.balloon").

------------- end of GENOPT user's activities ------------------

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* **PART 2** \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

TASKS PERFORMED BY **THE END USER**

---------------- begin end user's activities -------------------

Next, establish a specific name for a case that fits within the

generic class called "balloon". In this example, we use the

specific name, "try4". Then execute the GENOPT processors,

BEGIN, DECIDE, MAINSETUP, OPTIMIZE, as listed next. Let us

assume that this run stream is based on the balloon model

in which the webs form a truss-like configuration (bosdec.balloon,

Figs. 2 or 5 in [1] and Table 7 in the appendix of [1]).

COMMAND MEANING OF COMMAND

**begin** (provide the starting design, etc. Input file for

BEGIN = try4.BEG. If you already have a file, say,

/home/progs/genopt/case/balloon/try41.starting.beg,

then:

cp home/progs/genopt/case/balloon/try41.starting.beg try4.BEG

try4.BEG = Table 8 in the appendix of [1])

**decide** (provide decision variables, etc. Input file for

DECIDE = try4.DEC. If you already have a file, say,

/home/progs/genopt/case/balloon/try41.starting.dec,

then:

cp home/progs/genopt/case/balloon/try41.starting.dec try4.DEC

try4.DEC = Table 9 in the appendix of [1])

**mainsetup** (provide analysis type, strategy, etc. Input file for

MAINSETUP = try4.OPT. If you already have a file, say,

/home/progs/genopt/case/balloon/try41.OPT,

then:

cp home/progs/genopt/case/balloon/try41.OPT try4.OPT

try4.OPT = Table 10 in the appendix of [1].

IMPORTANT NOTE: At first, always use ITYPE=2, not ITYPE=1 .

That is, analyze a fixed design rather than do optimization.

After you carefully check to see that everything in the "fixed"

design execution is working properly, then you can do

optimization as described below.)

**optimize** (launch the OPTIMIZE run either to obtain results for

a fixed design or to do optimization or to do a

design sensitivity analysis. Let us assume that in

this case we analyze a fixed design [ITYPE = 2

in the try4.OPT file].)

Inspect the try4.OPM file. (No table for this file is included in [1].

It would be analogous to Table 11 in the appendix of [1].)

Suppose you used OPTIMIZE to obtain results for a fixed design, that is,

the starting design that you specified in the try4.BEG file (Table 8 in]

the appendix of [1]).

Next, you want to get plots of the buckling modes and the pre-

buckling deformations from direct executions of the version of

BIGBOSOR4 that is independent of the GENOPT system. Do the

following:

First, get a plot of the "general" buckling mode:

("general" is in quotes because the lowest buckling

load factor might well correspond to local buckling, not

general buckling. The lowest eigenvalue could correspond

either to local or to general buckling.)

COMMAND MEANING OF COMMAND

**cd /home/progs/work6** (go to a working space, "work6")

**bigbosor4log** (activate the BIGBOSOR4 set of commands)

**cp /home/progs/genoptcase/try4.BEHX1 try4.ALL**(get BIGBOSOR4 input file)

**bigbosorall** (execute BIGBOSOR4: input file = try2.ALL .

NOTE: valid input files for bigbosor4 always have the

suffix, ".ALL")

Inspect the try2.OUT file. Search for the string, "EIGENVALUE(",

including the trailing left parenthesis.

Next, you want to plot the buckling mode. Do the following:

COMMAND MEANING OF COMMAND

**bosorplot** (choose what to plot. Use "x" in response to

prompt if you want plot on your screen. Use "p"

in reponse to prompt if you want plot to be

in the file called "metafile.ps".)

**gv metafile.ps** (get a plot on your screen via the "ghost view"

utility, if "ghost view" is available on your

workstation. Fig. 6a in [1] is an edited version

of what appears on your screen.)

**cleanup** (Clean up the files generated by BIGBOSOR4)

NOTE: THE FOLLOWING LITTLE SECTION IS NOW OBSOLETE BECAUSE THERE IS

NO LONGER ANY \*.BEHX2 FILE GENERATED FOR THE GENERIC CASE, "balloon".

Figures 9 and 10 in [1] were generated by temporarily changing the

FORTRAN coding in SUBROUTINE BEHX2 in order to generate plots of

the pre-buckled state of the balloon at Load Step 1 (Fig.9) and at

Load Step 2 (Fig. 10).

--------------- BEGINNING OF THE LITTLE OBSOLETE SECTION --------------

Next, you want to plot the pre-buckling deformations for Load Step No. 1

and for Load Step No. 2. Do the following:

**cp /home/progs/genoptcase/try4.BEHX2 try4.ALL** (get BIGBOSOR4 input file)

**bigbosorall** (execute BIGBOSOR4: input file = try4.ALL)

Inspect the try4.OUT file. Search for the string, "LOAD STEP",

and look to see how many Newton iterations were required for convergence.

Next, you want to plot the pre-buckled state for Load Step 1 or 2.

Do the following:

COMMAND MEANING OF COMMAND

**bosorplot** (choose what to plot. Use "x" in response to

prompt if you want plot on your screen. Use "p"

in reponse to prompt if you want plot to be

in the file called "metafile.ps".)

**gv metafile.ps** (get a plot on your screen via the "ghost view"

utility, if "ghost view" is available on your

workstation. Fig. 9 in [1] is for Load Step 1)

**bosorplot** (choose what to plot. Use "x" in response to

prompt if you want plot on your screen. Use "p"

in reponse to prompt if you want plot to be

in the file called "metafile.ps".)

**gv metafile.ps** (get a plot on your screen via the "ghost view"

utility, if "ghost view" is available on your

workstation. Fig. 10 in [1] is for Load Step 2)

**cleanup** (Clean up the files generated by BIGBOSOR4)

--------------- END OF THE LITTLE OBSOLETE SECTION -------------------

**cd /home/progs/genoptcase** (return to genoptcase)

Next, suppose you want to optimize the specific case, "try4".

Before you do any optimization make as certain as possible that

your versions of behavior.new and bosdec.src are correct and

have been compiled by execution of the "genprograms" command.

.

First, you edit the try4.OPT file so that it appears as follows:

n $ Do you want a tutorial session and tutorial output?

0 $ Choose an analysis you DON'T want (1, 2,..), IBEHAV

0 $ NPRINT= output index (0=GOOD, 1=ok, 2=debug, 3=too much)

1 $ Choose type of analysis (1=opt., 2=fixed, 3=sensit.) ITYPE

5 $ How many design iterations in this run (3 to 25)?

n $ Take "shortcuts" for perturbed designs (Y or N)?

2 $ Choose 1 or 2 or 3 or 4 or 5 for IDESIGN

1 $ Choose 1 or 2 or 3 or 4 or 5 for move limits, IMOVE

y $ Do you want default (RATIO=10) for initial move limit jump?

y $ Do you want the default perturbation (dx/x = 0.05)?

n $ Do you want to have dx/x modified by GENOPT?

n $ Do you want to reset total iterations to zero (Type H)?

1 $ Choose IAUTOF= 1 or 2 or 3 or 4 or 5 or 6 to change X(i)

Then, type the following commands:

COMMAND MEANING OF COMMAND

**mainsetup** (use the try4.OPT file just listed as input)

**superopt** (launch the "global" optimizer. Use 5 OPTIMIZEs per

AUTOCHANGE)

SUPEROPT will require about 20 hours (for a model with 15 modules

such as that shown in Fig. 1 of [1]) if SUPEROPT runs successfully

to completion (about 470 design iterations).

------------BEGINNING OF A SMALL DIGRESSION ----------------------

Inspect the try4.OPP file to see if SUPEROPT finished successfully.

If it did, then there should be about 470 design iterations. Look

near the end of try4.OPP to inspect the best FEASIBLE design and

the best ALMOST FEASIBLE design.

Sometimes the SUPEOPT run aborts before there are about

470 design iterations. When that happens look at the

end of the \*.OPM file. You will probably find a message

such as occurred on October 19, 2010 in the try4.OPM file:

\*\*\*\*\*\*\*\*\*\*\*\*\* ABORT \*\*\*\*\*\*\*\*\*\*

0.5 x FLOUTR is greater than ROUTER

0.5 x FLOUTR = 7.1845E+00; ROUTER = 7.1000E+00; IMODX= 1

Put a higher lower bound on ROUTER.

The run is now aborting.

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

You can either follow the directions given in the "ABORT"

diagnostic by appropriately editing the try4.DEC file

(input for DECIDE), executing DECIDE and then re-launching

SUPEROPT.

Or you can accept the optimum design that SUPEROPT has produced

up to the point when the SUPEROPT run aborted by looking near

the end of the try4.OPP file and accepting either the

"BEST FEASIBLE" design or the "ALMOST FEASIBLE" design,

whichever you prefer.

NOTE: With "BEST FEASIBLE" designs all design margins

must be greater than -0.01. With "ALMOST FEASIBLE" designs

all design margins must be greater than -0.05.

If SUPEROPT quits before 470 design iterations, and you do

not see an "ABORT" message at the end of the \*.OPM file, then

look at the end of the \*.OUT file. You may find output such as

the following at the end of the \*.OUT file:

--- beginning of excerpt from the \*.OUT file of a run that terminated early ----

PRESSURE MULTIPLIER, P= 1.000000E-01, TEMPERATURE MULTIPLIER,TEMP = 1.000000E-01

ANGULAR VELOCITY, OMEGA= 0.000000E+00

PRESTRESS STIFFNESS MATRIX CALCULATED FOR ITERATION NO. 0. START FACTORING AND SOLVING

Factoring done for iteration 0; Load step, ISTEP= 1

FACTORING AND SOLVING COMPLETED FOR PRESTRESS ITERATION NO. 0

ITERATION NO. 0 MAXIMUM DISPLACEMENT= 2.4119E+01

PRESTRESS STIFFNESS MATRIX CALCULATED FOR ITERATION NO. 1. START FACTORING AND SOLVING

Factoring done for iteration 1; Load step, ISTEP= 1

FACTORING AND SOLVING COMPLETED FOR PRESTRESS ITERATION NO. 1

ITERATION NO. 1 MAXIMUM DISPLACEMENT= 1.9859E+01

PRESTRESS STIFFNESS MATRIX CALCULATED FOR ITERATION NO. 2. START FACTORING AND SOLVING

Factoring done for iteration 2; Load step, ISTEP= 1

FACTORING AND SOLVING COMPLETED FOR PRESTRESS ITERATION NO. 2

ITERATION NO. 2 MAXIMUM DISPLACEMENT= 4.8352E+01

PRESTRESS STIFFNESS MATRIX CALCULATED FOR ITERATION NO. 3. START FACTORING AND SOLVING

Factoring done for iteration 3; Load step, ISTEP= 1

FACTORING AND SOLVING COMPLETED FOR PRESTRESS ITERATION NO. 3

ITERATION NO. 3 MAXIMUM DISPLACEMENT= 5.8661E+01

PRESTRESS STIFFNESS MATRIX CALCULATED FOR ITERATION NO. 4. START FACTORING AND SOLVING

Factoring done for iteration 4; Load step, ISTEP= 1

FACTORING AND SOLVING COMPLETED FOR PRESTRESS ITERATION NO. 4

ITERATION NO. 4 MAXIMUM DISPLACEMENT= 3.3983E+02

PRESTRESS STIFFNESS MATRIX CALCULATED FOR ITERATION NO. 5. START FACTORING AND SOLVING

Factoring done for iteration 5; Load step, ISTEP= 1

FACTORING AND SOLVING COMPLETED FOR PRESTRESS ITERATION NO. 5

ITERATION NO. 5 MAXIMUM DISPLACEMENT= 4.1441E+03

PRESTRESS STIFFNESS MATRIX CALCULATED FOR ITERATION NO. 6. START FACTORING AND SOLVING

Factoring done for iteration 6; Load step, ISTEP= 1

FACTORING AND SOLVING COMPLETED FOR PRESTRESS ITERATION NO. 6

ITERATION NO. 6 MAXIMUM DISPLACEMENT= 1.6590E+06

PRESTRESS STIFFNESS MATRIX CALCULATED FOR ITERATION NO. 7. START FACTORING AND SOLVING

Factoring done for iteration 7; Load step, ISTEP= 1

FACTORING AND SOLVING COMPLETED FOR PRESTRESS ITERATION NO. 7

ITERATION NO. 7 MAXIMUM DISPLACEMENT= 9.7225E+10

PRESTRESS STIFFNESS MATRIX CALCULATED FOR ITERATION NO. 8. START FACTORING AND SOLVING

Factoring done for iteration 8; Load step, ISTEP= 1

FACTORING AND SOLVING COMPLETED FOR PRESTRESS ITERATION NO. 8

ITERATION NO. 8 MAXIMUM DISPLACEMENT= 2.5642E+16

PRESTRESS STIFFNESS MATRIX CALCULATED FOR ITERATION NO. 9. START FACTORING AND SOLVING

Factoring done for iteration 9; Load step, ISTEP= 1

FACTORING AND SOLVING COMPLETED FOR PRESTRESS ITERATION NO. 9

ITERATION NO. 9 MAXIMUM DISPLACEMENT= 8.0107E+21

PRESTRESS STIFFNESS MATRIX CALCULATED FOR ITERATION NO. 10. START FACTORING AND SOLVING

Factoring done for iteration 10; Load step, ISTEP= 1

FACTORING AND SOLVING COMPLETED FOR PRESTRESS ITERATION NO. 10

ITERATION NO. 10 MAXIMUM DISPLACEMENT= 7.5466E+30

PRESTRESS STIFFNESS MATRIX CALCULATED FOR ITERATION NO. 11. START FACTORING AND SOLVING

\*\*\*\*\*\*\*\*\*\* ALMOST SINGULAR STIFFNESS MATRIX \*\*\*\*\*\*\*\*\*\*

Maximum diagonal of factored matrix at iteration 0= 2.8868E+11

Maximum diagonal of factored matrix, current iter.= 3.3820E+27

Newton iterations now aborting.

\*\*\*\*\*\*\*\*\*\* ALMOST SINGULAR STIFFNESS MATRIX \*\*\*\*\*\*\*\*\*\*

Factoring done for iteration 11; Load step, ISTEP= 1

FACTORING AND SOLVING COMPLETED FOR PRESTRESS ITERATION NO. 11

ITERATION NO. 11 MAXIMUM DISPLACEMENT= 2.2389E+37

INITIAL LOADS TOO HIGH FOR THIS STRUCTURE. REDUCE THEM AND RERUN.

SHELL COLLAPSES AXISYMMETRICALLY AT P=0.1

--- end of excerpt from the \*.OUT file of a run that terminated early ---

If you find this kind of output in \*.OUT, then probably you should

increase either the lower bound of RINNER or increase the lower

bound of ROUTER, whichever of RINNER or ROUTER is closest to

its lower bound. If RINNER and/or ROUTER are not decision variables

then increase the value of the one of them that is not a decision

variable or the values of the both of them that are not decision

variables.

NOTE: RINNER should be greater than RADIUS x (pi/2)/(2 x NMODUL).

ROUTER should be greater than (RADIUS+HEIGHT) x (pi/2)/(2 x NMODUL).

---------------- END OF A SMALL DIGRESSION ----------------------

Next, obtain a plot of the objective versus design iterations.

Execute CHOOSEPLOT with the file, try4.CPL, as input:

try4.CPL file:

n $ Do you want a tutorial session and tutorial output?

n $ Any design variables to be plotted v. iterations (Y or N)?

n $ Any design margins to be plotted v. iterations (Y or N)?

n $ Do you want to get more plots before your next "SUPEROPT"?

COMMAND MEANING OF COMMAND

**chooseplot** (get plot file, objective v. design iterations)

**diplot** (this command produces the file, try4.5.ps)

**gv try4.5.ps** (your screen shows the plot from try4.5.ps

try4.5.ps = Fig. 6b in [1])

Next, you want to run OPTMIZE with the following input file, try4.OPT,

that is, you want to do an analysis of the fixed, optimized design::

n $ Do you want a tutorial session and tutorial output?

0 $ Choose an analysis you DON'T want (1, 2,..), IBEHAV

2 $ NPRINT= output index (0=GOOD, 1=ok, 2=debug, 3=too much)

2 $ Choose type of analysis (1=opt., 2=fixed, 3=sensit.) ITYPE

5 $ How many design iterations in this run (3 to 25)?

n $ Take "shortcuts" for perturbed designs (Y or N)?

2 $ Choose 1 or 2 or 3 or 4 or 5 for IDESIGN

1 $ Choose 1 or 2 or 3 or 4 or 5 for move limits, IMOVE

y $ Do you want default (RATIO=10) for initial move limit jump?

y $ Do you want the default perturbation (dx/x = 0.05)?

n $ Do you want to have dx/x modified by GENOPT?

n $ Do you want to reset total iterations to zero (Type H)?

1 $ Choose IAUTOF= 1 or 2 or 3 or 4 or 5 or 6 to change X(i)

COMMAND MEANING OF COMMAND

**mainsetup** (use the try4.OPT file just listed as input: fixed design)

**optimize** (get the try4.OPM file for the fixed, optimized design)

Inspect the try4.OPM file. try4.OPM = Table 11 in the appendix of [1].

Next, save the optimum design listed near the top of Table 11 of [1].

Next, we want to save the optimized design. If you do not have an

appropriate file called try4.CHG, do the following:

**change** (answer the prompts interactively)

If you do have an appropriate file, do the following:

cp /home/progs/genopt/case/balloon/try41.superopt1.chg try4.CHG

try41.superopt1.chg = Table 12 in the appendix of [1]

**change** (use the try4.CHG file as input)

**optimize** (analyze the fixed, optimized, design)

Next, we wish to do more optimization. Notice in the

try4.DEC file listed as Table 9 in [1] that the

variables, RINNER and ROUTER, are not decision variables.

These were not used as decision variables during the first

optimization in order to avoid prebuckling axisymmetric collapse,

which causes an early termination of the SUPEROPT execution

analogous to the type described earlier when SUPEROPT was first

executed. We wish now to introduce RINNER and ROUTER as additional

decision variables while keeping HEIGHT and the various wall

thicknesses as decision variables. Also, we may wish to change the

upper or lower bounds of one or more of the decision variables,

depending on the optimum design determined after the first SUPEROPT

execution. For example, if a thickness is at or near its lower

bound, we will probably want to lower that lower bound in the

\*.DEC file (input for DECIDE).

Do the following:

COMMAND MEANING OF COMMAND

**decide** (provide decision variables, etc. Input file for

DECIDE = try4.DEC. If you already have a file, say,

/home/progs/genopt/case/balloon/try41.dec2,

then:

cp /home/progs/genopt/case/balloon/try41.dec2 try4.DEC

try4.DEC = Table 13 in the appendix of [1])

**mainsetup** (use try4.OPT with NPRINT = 0 and ITYPE = 1 as input)

**superopt** (launch the "global" optimizer. Use 5 OPTIMIZEs per

AUTOCHANGE)

SUPEROPT will require about 20 hours (for a model with 15 modules)

if it runs successfully to completion (about 470 design iterations).

Inspect the try4.OPP file to see if SUPEROPT finished successfully.

If it did, then there should be about 470 design iterations. Look

near the end of try4.OPP to inspect the best FEASIBLE design and

the best ALMOST FEASIBLE design.

Next, obtain a plot of the objective versus design iterations.

Execute CHOOSEPLOT with the file, try4.CPL, as input:

try4.CPL

n $ Do you want a tutorial session and tutorial output?

n $ Any design variables to be plotted v. iterations (Y or N)?

n $ Any design margins to be plotted v. iterations (Y or N)?

n $ Do you want to get more plots before your next "SUPEROPT"?

COMMAND MEANING OF COMMAND

**chooseplot** (get plot file, objective v. design iterations)

**diplot** (this command produces the file, try4.5.ps)

**gv try4.5.ps** (your screen shows the plot from try4.5.ps)

try4.5.ps = Fig. 7 in [1]

Next, you want to run OPTMIZE with the following input file, try4.OPT:

n $ Do you want a tutorial session and tutorial output?

0 $ Choose an analysis you DON'T want (1, 2,..), IBEHAV

2 $ NPRINT= output index (0=GOOD, 1=ok, 2=debug, 3=too much)

2 $ Choose type of analysis (1=opt., 2=fixed, 3=sensit.) ITYPE

5 $ How many design iterations in this run (3 to 25)?

n $ Take "shortcuts" for perturbed designs (Y or N)?

2 $ Choose 1 or 2 or 3 or 4 or 5 for IDESIGN

1 $ Choose 1 or 2 or 3 or 4 or 5 for move limits, IMOVE

y $ Do you want default (RATIO=10) for initial move limit jump?

y $ Do you want the default perturbation (dx/x = 0.05)?

n $ Do you want to have dx/x modified by GENOPT?

n $ Do you want to reset total iterations to zero (Type H)?

1 $ Choose IAUTOF= 1 or 2 or 3 or 4 or 5 or 6 to change X(i)

COMMAND MEANING OF COMMAND

**mainsetup** (use the try4.OPT file just listed as input: fixed design)

**optimize** (get the try4.OPM file for the fixed, optimized design)

Inspect the try4.OPM file. try4.OPM = Table 14 in the appendix of [1].

Next, save the optimum design listed near the top of Table 14 of [1].

Next, we want to save the optimized design. If you do not have an

appropriate file called try4.CHG, do the following:

**change** (answer the prompts interactively)

If you do have an appropriate file, do the following:

cp /home/progs/genopt/case/balloon/try41.superopt2.chg try4.CHG

try41.superopt2.chg = Table 15 in the appendix of [1].

**change** (use the try4.CHG file as input)

**optimize** (analyze the fixed, optimized, design)

Next, we wish to do still more optimization, mainly because

the variable, HEIGHT, in the previous optimization reached its

lower bound: 50 inches. Hence, we decrease the lower bound from

50 to 40 inches. Do the following:

COMMAND MEANING OF COMMAND

**decide**  (provide decision variables, etc. Input file for

DECIDE = try4.DEC. If you already have a file, say,

/home/progs/genopt/case/balloon/try41.dec3,

then:

cp /home/progs/genopt/case/balloon/try41.dec3 try4.DEC

try4.DEC = Table 16 in in the appendix of [1])

**mainsetup** (use try4.OPT with NPRINT = 0 and ITYPE = 1 as input)

**superopt** (launch the "global" optimizer. Use 5 OPTIMIZEs per

AUTOCHANGE)

SUPEROPT will require about 20 hours (for a model with 15 modules)

if it runs successfully to completion (about 470 design iterations).

Inspect the try4.OPP file to see if SUPEROPT finished successfully.

If it did, then there should be about 470 design iterations. Look

near the end of try4.OPP to inspect the best FEASIBLE design and

the best ALMOST FEASIBLE design. It turns out in this case that the

best design is the same as the optimum design obtained after the

2nd execution of SUPEROPT (Table 14 in the appendix of [1]).

Next, obtain a plot of the objective versus design iterations.

Execute CHOOSEPLOT with the file, try4.CPL, as input:

try4.CPL

n $ Do you want a tutorial session and tutorial output?

n $ Any design variables to be plotted v. iterations (Y or N)?

n $ Any design margins to be plotted v. iterations (Y or N)?

n $ Do you want to get more plots before your next "SUPEROPT"?

COMMAND MEANING OF COMMAND

**chooseplot** (get plot file, objective v. design iterations)

**diplot** (this command produces the file, try4.5.ps)

**gv try4.5.ps** (your screen shows the plot from try4.5.ps

try4.5.ps = Fig. 8 in [1])

Next, you want to get a plot of the buckling mode of the

optimized design from a direct execution of the version of

BIGBOSOR4 that is independent of the GENOPT system.

Do the following:

COMMAND MEANING OF COMMAND

**cd /home/progs/work6** (go to a working space, "work6")

**bigbosor4log** (activate the BIGBOSOR4 set of commands)

**cp /home/progs/genoptcase/try4.BEHX1 try4.ALL**  (get BIGBOSOR4 input file)

**bigbosorall** (execute BIGBOSOR4: input file = try4.ALL)

Inspect the try4.OUT file. Search for the string, "EIGENVALUE(",

including the trailing left parenthesis.

Next, you want to plot the buckling mode. Do the following:

COMMAND MEANING OF COMMAND

**bosorplot** (choose what to plot. Use "x" in response to

prompt if you want plot on your screen. Use "p"

in reponse to prompt if you want plot to be

in the file called "metafile.ps".)

**gv metafile.ps** (get a plot on your screen via the "ghost view"

utility, if "ghost view" is available on your

workstation. metafile.ps, with some editing,

produces Fig. 11 in [1].)

**cleanup** (Clean up the files generated by BIGBOSOR4)

The input file for BIGBOSOR4 generated by SUBROUTINE BOSDEC is,

in the specific case, “try4”, called “try4.BEHX1”. This file does

not have the usual complete annotation for each datum that is

typical of ordinary BIGBOSOR4 input files called “\*.ALL”. One

of the important things that the command, “cleanup”, does is to

produce a properly annotated input file, “\*.ALL”, for BIGOBOSOR4.

Before the “cleanup” command just listed the input files, try4.BEHX1

= try4.ALL, have the following lines (corresponding to the initial

input data followed by the input data only for the first shell

segment in this example):

general buckling, 12-module model (INDIC=1) ixprism

6.000000E+03 $ AXIALL = axial length of cyl.

1 1, 0, 64 $ INDIC,NPRT,ISTRESS,NSEG

H $ Segment number 1 1 1 1

31, 3, 1 $ NMESH,NTYPEH,NSHAPE

3.819719E+01 1.877272E+02 5.050148E+01 1.877272E+02 $ R1,Z1,R2,Z2

0, 3, 2.807000E-02 $ IMP,NTYPEZ,ZVAL

N $ do not print r(s), etc.

0 0.000000E+00 0 3 $ NRINGS,K,LINTYP,IDISAB

3 2 0 0 1 $ NLTYPE,NPSTAT,NLOAD(1),NLOAD(2),NLOAD(3)

0.000000E+00 0.000000E+00 $ PN(1),PN(2)

1 1 31 $ NTYPE,IPOINT(1),IPOINT(2)

2 1 1 0 0 $ NTSTAT,NTGRAD,NLOAD(1),NLOAD(2),NLOAD(3)

0.000000E+00 0.000000E+00 $ T1(1),T1(2)

1 1 31 $ NTYPE,IPOINT(1),IPOINT(2)

3 2 0 0 1 $ NLTYPE,NPSTAT,NLOAD(1),NLOAD(2),NLOAD(3)

0.000000E+00 0.000000E+00 $ PN(1),PN(2)

1 1 31 $ NTYPE,IPOINT(1),IPOINT(2)

2 1 1 0 0 $ NTSTAT,NTGRAD,NLOAD(1),NLOAD(2),NLOAD(3)

-1.114082E+02 -1.114082E+02 $ T1(1),T1(2)

1 1 31 $ NTYPE,IPOINT(1),IPOINT(2)

4 1 $ NWALL,NLAYER

1 $ layer index

Y $ is this a new layer type?

5.614000E-02 0.000000E+00 2 $ thickness,angle,material

Y $ Is this material new?

4.351000E+05 4.351000E+05 1.673460E+05 3.000000E-01 $ E1,E2,G12,NU

1.000000E-10 1.000000E-04 0.000000E+00 1.000000E-01 $ A1,A2,TEMPTUR,DENS

1.000000E+04 1.000000E+04 1.000000E+04 $ S(1),S(2),S(3)

1.000000E+04 1.000000E+04 $ S(4),S(5)

0 $ no additional smeared stiffeners

Y $ do you want output for all nodes?

N $ do you want to print out Cij?

N $ do you want to print out loads?

(many, many more lines are omitted here in order to save space)

After the “cleanup” command the same input data are arranged in the

completely annotated form, as follows:

general buckling, 12-module model (INDIC=1) ixprism

6000.000 $ AXIALL= length of the prismatic shell

1 $ INDIC = analysis type indicator

1 $ NPRT = output options (1=minimum, 2=medium, 3=maximum)

0 $ ISTRES= output control (0=resultants, 1=sigma, 2=epsilon)

64 $ NSEG = number of shell segments (less than 295)

H $

H $ SEGMENT NUMBER 1 1 1 1 1 1 1 1

H $ NODAL POINT DISTRIBUTION FOLLOWS...

31 $ NMESH = number of node points (5 = min.; 98 = max.)( 1)

3 $ NTYPEH= control integer (1 or 3) for nodal point spacing

H $ REFERENCE SURFACE GEOMETRY FOLLOWS...

1 $ NSHAPE= indicator (1,2 or 4) for geometry of meridian

38.19719 $ R1 = radius at beginning of segment (see p. 66)

187.7272 $ Z1 = global axial coordinate at beginning of segment

50.50148 $ R2 = radius at end of segment

187.7272 $ Z2 = global axial coordinate at end of segment

H $ IMPERFECTION SHAPE FOLLOWS...

0 $ IMP = indicator for imperfection (0=none, 1=some)

H $ REFERENCE SURFACE LOCATION RELATIVE TO WALL

3 $ NTYPEZ= control (1 or 3) for reference surface location

0.2807000E-01 $ ZVAL = distance from leftmost surf. to reference surf.

N $ Do you want to print out r(s), r'(s), etc. for this segment?

H $ DISCRETE RING INPUT FOLLOWS...

0 $ NRINGS= number (max=20) of discrete rings in this segment

0.000000 $ K=elastic foundation modulus (e.g. lb/in\*\*3)in this seg.

H $ LINE LOAD INPUT FOLLOWS...

0 $ LINTYP= indicator (0, 1, 2 or 3) for type of line loads

H $ DISTRIBUTED LOAD INPUT FOLLOWS...

3 $ IDISAB= indicator (0, 1, 2 or 3) for load set A and B

H $ SURFACE LOAD INPUT FOR LOAD SET "A" FOLLOWS

3 $ NLTYPE=control (0,1,2,3) for type of surface loading

2 $ NPSTAT= number of meridional callouts for surface loading

0 $ NLOAD(1)=indicator for meridional traction (0=none, 1=some)

0 $ NLOAD(2)=indicator for circumferential traction

1 $ NLOAD(3)=indicator for normal pressure (0=none, 1=some)

0.000000 $ PN(i) = normal pressure (p.74) at ith callout, PN( 1)

0.000000 $ PN(i) = normal pressure (p.74) at ith callout, PN( 2)

1 $ NTYPE = control for meaning of loading callout (2=z, 3=r)

1 $ IPOINT(I)=segment nodal point of the Ith callout( 1)

31 $ IPOINT(I)=segment nodal point of the Ith callout( 2)

2 $ NTSTAT= number of meridional callouts for temperature

1 $ NTGRAD=control for type of thermal gradient thru thickness

1 $ NLOAD(1)=indicator for temperature coef. T1 (0=none, 1=some)

0 $ NLOAD(2)=indicator for temperature coef. T2 (0=none, 1=some)

0 $ NLOAD(3)=indicator for temperature coef. T3 (0=none, 1=some)

0.000000 $ T1 = temperature factor at Ith meridional callout, T1( 1)

0.000000 $ T1 = temperature factor at Ith meridional callout, T1( 2)

1 $ NTYPE = control for meaning of callout (2=z, 3=r)

1 $ IPOINT(I)=segment nodal point of the Ith callout( 1)

31 $ IPOINT(I)=segment nodal point of the Ith callout( 2)

H $ SURFACE LOAD INPUT FOR LOAD SET "B" FOLLOWS

3 $ NLTYPE=control (0,1,2,3) for type of surface loading

2 $ NPSTAT= number of meridional callouts for surface loading

0 $ NLOAD(1)=indicator for meridional traction (0=none, 1=some)

0 $ NLOAD(2)=indicator for circumferential traction

1 $ NLOAD(3)=indicator for normal pressure (0=none, 1=some)

0.000000 $ PN(i) = normal pressure (p.74) at ith callout, PN( 1)

0.000000 $ PN(i) = normal pressure (p.74) at ith callout, PN( 2)

1 $ NTYPE = control for meaning of loading callout (2=z, 3=r)

1 $ IPOINT(I)=segment nodal point of the Ith callout( 1)

31 $ IPOINT(I)=segment nodal point of the Ith callout( 2)

2 $ NTSTAT= number of meridional callouts for temperature

1 $ NTGRAD=control for type of thermal gradient thru thickness

1 $ NLOAD(1)=indicator for temperature coef. T1 (0=none, 1=some)

0 $ NLOAD(2)=indicator for temperature coef. T2 (0=none, 1=some)

0 $ NLOAD(3)=indicator for temperature coef. T3 (0=none, 1=some)

-111.4082 $ T1 = temperature factor at Ith meridional callout, T1( 1)

-111.4082 $ T1 = temperature factor at Ith meridional callout, T1( 2)

1 $ NTYPE = control for meaning of callout (2=z, 3=r)

1 $ IPOINT(I)=segment nodal point of the Ith callout( 1)

31 $ IPOINT(I)=segment nodal point of the Ith callout( 2)

H $ SHELL WALL CONSTRUCTION FOLLOWS...

4 $ NWALL=index (1, 2, 4, 5, 6, 7, 8, 9, 10) for wall construction

1 $ number of layers in the wall

1 $ layer index (1,2,...), for layer no.( 1)

Y $ Is this a new layer type?

0.5614000E-01 $ thickness for layer index no.( 1)

0.000000 $ winding angle (deg.) for layer index no.( 1)

2 $ material index (1,2,...) for layer index no.( 1)

Y $ Next material type... Is material new for material type( 2)

435100.0 $ modulus in the fiber direction, E1( 2)

435100.0 $ modulus transverse to fibers, E2( 2)

167346.0 $ in-plane shear modulus, G( 2)

0.3000000 $ small Poisson's ratio, NU( 2)

0.1000000E-09 $ thermal expansion along fibers, A1( 2)

0.1000000E-03 $ transverse thermal expansion, A2( 2)

0.000000 $ residual stress temperature (positive),TEMPTUR( 2)

0.1000000 $ mass density (e.g. lb-sec\*\*2/in. Aluminum=.00025), DENS( 2)

10000.00 $ maximum tensile stress along fibers, matl( 2)

10000.00 $ max compressive stress along fibers, matl( 2)

10000.00 $ max tensile stress normal to fibers, matl( 2)

10000.00 $ max compress stress normal to fibers,matl( 2)

10000.00 $ maximum shear stress in material type( 2)

0 $ NRS = control (0 or 1) for addition of smeared stiffeners

Y $ Do you want output for all the nodal points in Segment( 1)

N $ Do you want to print out the C(i,j) at meridional stations?

N $ Do you want to print out distributed loads along meridian?

H $

(many, many more lines are omitted here in order to save space)

It is easier to find a specific input datum when the BIGBOSOR4

input file is in the properly annotated form as just listed.

Next, we want to get more than one buckling eigenvector. In this

particular case the lowest eigenvalue happens to correspond to

general buckling (Fig. 11 of [1]), and we want next to see what

some local buckling modes look like. Therefore, we do the following:

Edit the "cleaned up" (properly annotated) file, try4.ALL, as follows:

Search for the string, "NVEC". (NOTE: “NVEC” does not appear

in the properly annotated list above because it occurs in a

later section of the try4.ALL file not included there in order

to save space.)

Change NVEC from 1 to 10. Then do the following:

COMMAND MEANING OF COMMAND

**bigbosorall** (execute BIGBOSOR4: input file=try4.ALL)

Inspect the try4.OUT file. Search for the string, "EIGENVALUE(",

including the trailing left parenthesis. Just above, you will

see 10 eigenvalues, all clustered very close together. The first

eigenvalue in this particular case corresponds to global buckling

as displayed in Fig. 11 of [1]. Eigenvalues 2 - 9 correspond to

various combinations of local buckling and general buckling, as

shown, for examples, in Figs. 13 and 14 of [1]. The 10th

eigenvalue in this particular case corresponds to almost pure

local buckling, as shown in Fig. 12 of [1].

Next, you want to plot some of the "higher" buckling modes.

Do the following:

COMMAND MEANING OF COMMAND

**bosorplot**  (choose the 2nd eigenvalue. Use "x" in response to

prompt if you want plot on your screen. Use "p"

in reponse to prompt if you want plot to be

in the file called "metafile.ps".)

**gv metafile.ps** (get a plot on your screen via the "ghost view"

utility, if "ghost view" is available on your

workstation. metafile.ps, with some editing,

produces Fig. 13 in [1].)

**bosorplot** (choose the 3rd eigenvalue. Use "x" in response to

prompt if you want plot on your screen. Use "p"

in reponse to prompt if you want plot to be

in the file called "metafile.ps".)

**gv metafile.ps** (get a plot on your screen via the "ghost view"

utility, if "ghost view" is available on your

workstation. metafile.ps, with some editing,

produces Fig. 14 in [1].)

**bosorplot** (choose the 10th eigenvalue. Use "x" in response to

prompt if you want plot on your screen. Use "p"

in reponse to prompt if you want plot to be

in the file called "metafile.ps".)

**gv metafile.ps** (get a plot on your screen via the "ghost view"

utility, if "ghost view" is available on your

workstation. metafile.ps, with some editing,

produces Fig. 12 in [1].)

**cleanup** (Clean up the files generated by BIGBOSOR4)

**cd /home/progs/genoptcase** (return to genoptcase)

Next, use GENOPT/BIGBOSOR4 to do "design sensitivity" analyses

(ITYPE = 3 in the \*.OPT file).

Suppose you want to obtain a plot of the buckling margin as a function

of the radius, ROUTER, of the local outward "bulges" in the outer membrane.

Ordinarily, the optimum value of ROUTER should fall approximately in

the middle of the range of ROUTER explored in this "design sensitivity"

analysis (ITYPE=3 in the try4.OPT file). The try4.OPT file should

be as follows in this particular case:

n $ Do you want a tutorial session and tutorial output?

0 $ Choose an analysis you DON'T want (1, 2,..), IBEHAV

2 $ NPRINT= output index (0=GOOD, 1=ok, 2=debug, 3=too much)

3 $ Choose type of analysis (1=opt., 2=fixed, 3=sensit.) ITYPE

3 $ Choose a design variable (1, 2, 3, ...), IBVAR

8.95000 $ Starting value of the design parameter, VARBEG

12.95000 $ Ending value of the design parameter, VAREND

n $ Do you want to use the default for the number of steps?

11 $ Number of steps from VARBEG to VAREND. NSTEPS

COMMAND MEANING OF COMMAND

**mainsetup** (use the try4.OPT file just listed as input)

**optimize** (get the try4.OPM file for the range of ROUTER)

Next, obtain a plot of the buckling and stress margins versus ROUTER:

**chooseplot** (choose what to plot versus the range of ROUTER.

The input file in this case, try4.CPL, follows:)

n $ Do you want a tutorial session and tutorial output?

y $ Any design margins to be plotted v. iterations (Y or N)?

1 $ Choose a margin to be plotted v. iterations (1,2,3,..)

y $ Any more margins to be plotted (Y or N) ?

2 $ Choose a margin to be plotted v. iterations (1,2,3,..)

y $ Any more margins to be plotted (Y or N) ?

4 $ Choose a margin to be plotted v. iterations (1,2,3,..)

y $ Any more margins to be plotted (Y or N) ?

7 $ Choose a margin to be plotted v. iterations (1,2,3,..)

y $ Any more margins to be plotted (Y or N) ?

9 $ Choose a margin to be plotted v. iterations (1,2,3,..)

y $ Any more margins to be plotted (Y or N) ?

12 $ Choose a margin to be plotted v. iterations (1,2,3,..)

y $ Any more margins to be plotted (Y or N) ?

14 $ Choose a margin to be plotted v. iterations (1,2,3,..)

n $ Any more margins to be plotted (Y or N) ?

1 $ Give maximum value (positive) to be included in plot frame.

COMMAND MEANING OF COMMAND

**diplot** (diplot creates try4.3.ps and try4.5.ps. The

design margins chosen in CHOOSEPLOT" are in

the file, try4.3.ps and the objective versus

ROUTER is in the file, try4.5.ps.)

**gv try4.3.ps** (this command shows the plot of the design

margins versus ROUTER for 8.95 < ROUTER < 12.95.

The plot is displayed in Fig. 17 in [1].)

Do an analogous "design sensitivity" study (ITYPE = 3 in the \*.OPT file)

with use of RINNER as the changing decision variable. The input to

MAINSETUP is as follows:

n $ Do you want a tutorial session and tutorial output?

0 $ Choose an analysis you DON'T want (1, 2,..), IBEHAV

2 $ NPRINT= output index (0=GOOD, 1=ok, 2=debug, 3=too much)

3 $ Choose type of analysis (1=opt., 2=fixed, 3=sensit.) ITYPE

2 $ Choose a design variable (1, 2, 3, ...), IBVAR

6.280400 $ Starting value of the design parameter, VARBEG

7.000000 $ Ending value of the design parameter, VAREND

n $ Do you want to use the default for the number of steps?

11 $ Number of steps from VARBEG to VAREND. NSTEPS

The relevant plot is Fig. 16 in [1].

Do an analogous "design sensitivity" study (ITYPE = 3 in the \*.OPT file)

with use of HEIGHT as the changing decision variable. The input to

MAINSETUP is as follows:

n $ Do you want a tutorial session and tutorial output?

0 $ Choose an analysis you DON'T want (1, 2,..), IBEHAV

2 $ NPRINT= output index (0=GOOD, 1=ok, 2=debug, 3=too much)

3 $ Choose type of analysis (1=opt., 2=fixed, 3=sensit.) ITYPE

1 $ Choose a design variable (1, 2, 3, ...), IBVAR

40.00000 $ Starting value of the design parameter, VARBEG

60.00000 $ Ending value of the design parameter, VAREND

n $ Do you want to use the default for the number of steps?

11 $ Number of steps from VARBEG to VAREND. NSTEPS

The relevant plot is Fig. 15 in [1].

Up to this point we have used POUTER = 5.0 psi and a factor of safety

of 3.0 for buckling. Although the "real" case has POUTER = 15.0 psi and

factor of safety for buckling of 1.0, we have used the lower POUTER and

the higher factor of safety in order to avoid pre-buckling collapse

during optimization cycles. Hence, we must next check the optimized

design with the use of POUTER = 15.0 psi and factor of safety for

buckling of 1.0. Do the following:

COMMAND MEANING OF COMMAND

**cleanspec** (clean up the files with the specific name, try4)

Edit the try4.BEG file (Table 8 in the appendix of [1]), making

the following changes:

The following lines in the try4.BEG file:

5.00000 $ pressure outside the outer membrane: POUTER( 1)

1.000000 $ allowable for general buckling load factor: GENBUKA( 1)

3.000000 $ general buckling factor of safety: GENBUKF( 1)

should be changed to the following lines in the new try4.BEG file:

15.00000 $ pressure outside the outer membrane: POUTER( 1)

1.000000 $ allowable for general buckling load factor: GENBUKA( 1)

1.000000 $ general buckling factor of safety: GENBUKF( 1)

Then, do the following:

COMMAND MEANING OF COMMAND

**begin** (input is the new try4.BEG file)

**change** (input is the file, try41.superopt2.chg:

cp /home/progs/genopt/case/balloon/try41.superopt2.chg try4.CHG

Table 15 in the appendix of [1])

**decide** (input is the file, try41.dec2:

cp /home/progs/genopt/case/balloon/try41.dec2 try4.DEC

Table 13 in the appendix of [1])

**mainsetup** (input is the file, try41.OPT:

cp /home/progs/genopt/case/balloon/try41.OPT try4.OPT

Table 10 in [1] with NPRINT=2 and ITYPE = 2 for the

analysis of the fixed, optimized design)

**optimize** (run OPTIMIZE and inspect the try4.OPM file.

try4.OPM = try41.optimum.POUTER15.opm = Table 17 in

the appendix of [1])

Next, you want to get a plot of the buckling mode of the

optimized design from a direct execution of the version of

BIGBOSOR4 that is independent of the GENOPT system.

Do the following:

COMMAND MEANING OF COMMAND

**cd /home/progs/work6** (go to a working space, "work6")

**bigbosor4log**  (activate the BIGBOSOR4 set of commands)

**cp /home/progs/genoptcase/try4.BEHX1 try4.ALL** (get BIGBOSOR4 input file)

**bigbosorall** (execute BIGBOSOR4: input file = try4.ALL)

Inspect the try4.OUT file. Search for the string, "EIGENVALUE(",

including the trailing left parenthesis.

Next, you want to plot the buckling mode. Do the following:

COMMAND MEANING OF COMMAND

**bosorplot** (choose what to plot. Use "x" in response to

prompt if you want plot on your screen. Use "p"

in reponse to prompt if you want plot to be

in the file called "metafile.ps".)

**gv metafile.ps** (get a plot on your screen via the "ghost view"

utility, if "ghost view" is available on your

workstation. metafile.ps, with some editing,

produces results essentially the same as

Fig. 11 in [1].)

**cleanup** (Clean up the files generated by BIGBOSOR4)

**cd /home/progs/genoptcase** (return to genoptcase)

**WHAT IF A SUPEROPT RUN ABORTS BEFORE REACHING ABOUT 470 DESIGN ITERATIONS?**

NOTE: THE FOLLOWING DESCRIPTION APPLIES TO THE STRATEGY IN EXISTENCE BEFORE “**Try no. 3**” WAS ADDED (See **Item 9** in **Section 8** of [1]).

The following output from a \*.OPM file shows what is listed in the \*.OPM file during processing that is at first normal, but then “double” failure to achieve nonlinear pre-buckling convergence leads to an unrecoverable situation and therefore the SUPEROPT run aborts. Advice is given to the user about how to proceed.

**Output from a \*.OPM file before at the moment of an unrecoverable error**

------------------------------------------------------------------------

Part of the try4.OPM file during optimization cycles

Ths excerpt from the try4.OPM file generated for

optimization (ITYPE = 1 in the try4.OPT file)

shows output when unrecoverable pre-buckling

nonlinear collapse occurs.

========================================================

STRUCTURAL ANALYSIS FOR DESIGN ITERATION NO. 3:

STRUCTURAL ANALYSIS WITH UNPERTURBED DECISION VARIABLES

VAR. DEC. ESCAPE LINK. LINKED LINKING LOWER CURRENT UPPER DEFINITION

NO. VAR. VAR. VAR. TO CONSTANT BOUND VALUE BOUND

1 Y N N 0 0.00E+00 2.00E+01 7.6412E+01 1.20E+02 height from inner to outer membranes: HEIGHT

2 N N N 0 0.00E+00 0.00E+00 1.6000E+01 0.00E+00 radius of curvature of inner membrane: RINNER

3 N N N 0 0.00E+00 0.00E+00 3.0000E+01 0.00E+00 radius of curvature of outer membrane: ROUTER

4 Y N N 0 0.00E+00 3.00E-02 9.4838E-02 3.00E-01 thickness of the inner curved membrane: TINNER

5 Y N N 0 0.00E+00 3.00E-02 1.7850E-01 3.00E-01 thickness of the outer curved membrane: TOUTER

6 Y N N 0 0.00E+00 3.00E-02 1.4529E-01 3.00E-01 thickness of inner truss-core segment: TFINNR

7 Y Y N 0 0.00E+00 3.00E-02 3.1920E-02 3.00E-01 thickness of the outer truss segment: TFOUTR

8 Y Y N 0 0.00E+00 3.00E-02 1.8814E-01 3.00E-01 thickness of each truss-core web: TFWEBS

Newton iterations required to solve the nonlinear

axisymmetric pre-buckling equilibrium state for the

"fixed" loads, PINNER= 0.0000E+00, PMIDDL= 6.0000E+01, DELTAT= -1.0274E+02

LOAD STEP Newton iterations Maximum displacement

1 11 4.702700E-01

2 2 9.389533E-01

3 2 1.406679E+00

4 2 1.873601E+00

5 2 2.339956E+00

6 2 2.805957E+00

7 2 3.271797E+00

8 2 3.737653E+00

9 1 4.203687E+00

10 2 4.670050E+00

WRDCOL=

IMODX=0 for current design,

IMODX=1 for perturbed design: IMODX= 0

Changes in temperature required to create 2 total axial loads:

1. Change in temperature required to create the axial thermal

strain that generates the axial tension due to closing the

two ends of the pressurized volume (PMIDDL= 6.0000E+01)

between the inner and outer walls of the balloon in

Load Step No. 1: DELTAT= -1.0274E+02

2. Change in temperature required to simulate the Poisson

axial expansion caused by the application of the outer

pressure, POUTER = 5.0000E+00 in Load Step No. 2: DELT= 0.0000E+00

GENERAL BUCKLING LOAD FACTORS AND MODES (BEHX1)

3.0538E+00( 1)

Critical buckling load factor, GENBUK= 3.0538E+00

Critical number of axial half-waves, NWVCRT= 1

Differences in the resultants along the axis of the prismatic

balloon for each segment, J, of the first module:

[N2VAR(J) for the total load] - [N2FIX(J) for the fixed load]=

N2DIFF(J),J=1,6)= -3.0402E+01 -6.1806E+01 -2.0300E+02 -1.1364E+01

-4.6538E+01 -3.0465E+01

N2VAR(J) (total load) are the resultants from Load Step No. 2.

N2FIX(J) (fixed load) are the resultants from Load Step No. 1.

NOTE: The stresses used as behavioral constraints are

computed from N2VAR(J)/thickness(J). These stresses are

lower than those computed from N2FIX(J)/thickness(J).

Newton iterations required to solve the nonlinear

axisymmetric pre-buckling equilibrium state for the

"fixed" loads (PINNER, PMIDDL, DELTAT): ITER= 1

Maximum displacement, FMAX= 4.6700E+00

Newton iterations required to solve the nonlinear

axisymmetric pre-buckling equilibrium state for the

total loads (PINNER, PMIDDL, DELTAT, POUTER): ITER= 2

Maximum displacement, FMAX= 3.4400E+00

\*\*\*\*\* RESULTS FOR LOAD SET NO. 1 \*\*\*\*\*\*

\*\*\*\*\*\*\* NOTE \*\*\*\*\*\*\* NOTE \*\*\*\*\*\*\* NOTE \*\*\*\*\*\* NOTE \*\*\*\*\*\*

The phrase, "NOT APPLY", for MARGIN VALUE means that that

particular margin value is exactly zero.

\*\*\* END NOTE \*\*\* END NOTE \*\*\* END NOTE \*\*\* END NOTE \*\*\*\*\*

\*\*\*\*\* RESULTS FOR LOAD SET NO. 1 \*\*\*\*\*\*

MARGINS LESS THAN CONMAX-1 CORRESPONDING TO CURRENT DESIGN

MARGIN CURRENT

NO. VALUE DEFINITION

1 1.792E-02 (GENBUK(1 )/GENBUKA(1 )) / GENBUKF(1 )-1; F.S.= 3.00

2 -2.373E-02 (STRM1A(1 ,1 )/STRM1(1 ,1 )) / STRM1F(1 ,1 )-1; F.S.= 1.00

3 3.257E-01 (STRM1A(1 ,3 )/STRM1(1 ,3 )) / STRM1F(1 ,3 )-1; F.S.= 1.00

4 3.136E-02 (STRM2A(1 ,1 )/STRM2(1 ,1 )) / STRM2F(1 ,1 )-1; F.S.= 1.00

5 3.552E-01 (STRM2A(1 ,3 )/STRM2(1 ,3 )) / STRM2F(1 ,3 )-1; F.S.= 1.00

6 2.832E-02 (STRM3A(1 ,1 )/STRM3(1 ,1 )) / STRM3F(1 ,1 )-1; F.S.= 1.00

7 3.536E-01 (STRM3A(1 ,3 )/STRM3(1 ,3 )) / STRM3F(1 ,3 )-1; F.S.= 1.00

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* DESIGN OBJECTIVE \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

\*\*\*\*\*\*\*\*\*\*\*\*\* \*\*\*\*\*\*\*\*\*\*\*

CURRENT VALUE OF THE OBJECTIVE FUNCTION:

VAR. CURRENT

NO. VALUE DEFINITION

1 9.277E+01 weight/length of the balloon: WEIGHT

\*\*\*\*\*\*\*\*\*\*\*\*\* \*\*\*\*\*\*\*\*\*\*\*\*

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* DESIGN OBJECTIVE \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

WRDCOL=

IMODX=0 for current design,

IMODX=1 for perturbed design: IMODX= 1

WRDCOL=

IMODX=0 for current design,

IMODX=1 for perturbed design: IMODX= 1

Decision variable candidates, HEIGHT,RINNER,ROUTER,TINNER,TOUTER=

7.641174E+01 1.600000E+01 3.000000E+01 9.483758E-02 1.874235E-01

TFINNR,TFOUTR,TFWEBS= 1.4529E-01 3.1920E-02 1.8814E-01

\*\*\*\*\*\* CHANGE FROM 10 TO 1 LOAD STEPS \*\*\*\*\*\*

INITIAL LOADS TOO HIGH FOR THIS STRUCT

Changing from 10 to 1 steps: IMODX= 1

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

WRDCOL=

IMODX=0 for current design,

IMODX=1 for perturbed design: IMODX= 1

Decision variable candidates, HEIGHT,RINNER,ROUTER,TINNER,TOUTER=

7.641174E+01 1.600000E+01 3.000000E+01 9.483758E-02 1.784986E-01

TFINNR,TFOUTR,TFWEBS= 1.5255E-01 3.1920E-02 1.8814E-01

\*\*\*\*\*\* CHANGE FROM 10 TO 1 LOAD STEPS \*\*\*\*\*\*

INITIAL LOADS TOO HIGH FOR THIS STRUCT

Changing from 10 to 1 steps: IMODX= 1

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

Decision variable candidates, HEIGHT,RINNER,ROUTER,TINNER,TOUTER=

7.641174E+01 1.600000E+01 3.000000E+01 9.483758E-02 1.784986E-01

TFINNR,TFOUTR,TFWEBS= 1.5255E-01 3.1920E-02 1.8814E-01

\*\*\*\*\*\*\*\*\*\*\*\*\* ABORT \*\*\*\*\*\*\*\*\*\*

INITIAL LOADS TOO HIGH FOR THIS STRUCT

This is an unrecoverable error because we have already

tried and failed to obtain nonlinear pre-buckling convergence

by changing from a nonlinear solution with 10 load steps to

a nonlinear solution with 1 load step. That strategy just

failed. You may well have performed enough design iterations

to have a good optimum design now. Look near the end of the

\*.OPP file at the "FEASIBLE" and "ALMOST FEASIBLE" designs.

If you are not satisfied that you have performed enough

design iterations, then look at the thicknesses of the

various segments. If any thicknesses seem too small, then

increase them and also increase the corresponding lower

bounds of them. Another thing you can try that has worked

for Bushnell is to look near the end of the \*.OPM file for

the last successfully obtained design. Use the GENOPT

processor, CHANGE, to reset the values of the decision

variables to those of the last successfully obtained design

and then launch a new execution of SUPEROPT, probably

leaving the lower bounds unchanged, or perhaps also changing

them if you wish (before launching SUPEROPT, of course).

The run is now aborting: IMODX= 1

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

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---------------- end of end user's activities -------------------

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