

Automatic processes for multiple analyses

4th German LS-DYNA Forum 2005

Miles Thornton

Christopher Bell, David Burton, Paul Davidson,
Ben Dennis, Roger Hollamby, Richard Sturt

Correspondence:

Miles Thornton
The Arup Campus
Blythe Gate, Blythe Valley Park
Solihull, W.Midlands B90 8AE
Tel: +44 (0)121 213 3399
Fax: +44 (0)121 213 3302
dyna.support@arup.com

ARUP

Contents

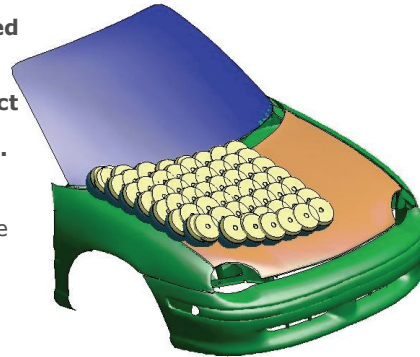
- **Introduction**
- **Example 1: Pedestrian headform impact**
- **Example 2: Multiple crash cases**
- **Example 3: Interior head impact**
- **Summary and Conclusions**

European LS-DYNA Conference 2005

ARUP

Introduction

- Significant amounts of time are wasted creating and processing multiple loadcases that are virtually identical.
- For example, pedestrian bonnet impact may require over 100 analyses to be set up, submitted and post-processed.
- Approximate timing for manual method:
 - 10 minutes per analysis to position the headform and depenetrate from the bonnet
 - 1 minute to submit
 - 10 minutes to check and post-process per analysis
 - 4 hours to collate results, calculate NCAP score and generate report
 - Total **39 hours** for 100 analyses, per design iteration
- Total man-time for automatic method: **10 minutes per design iteration**

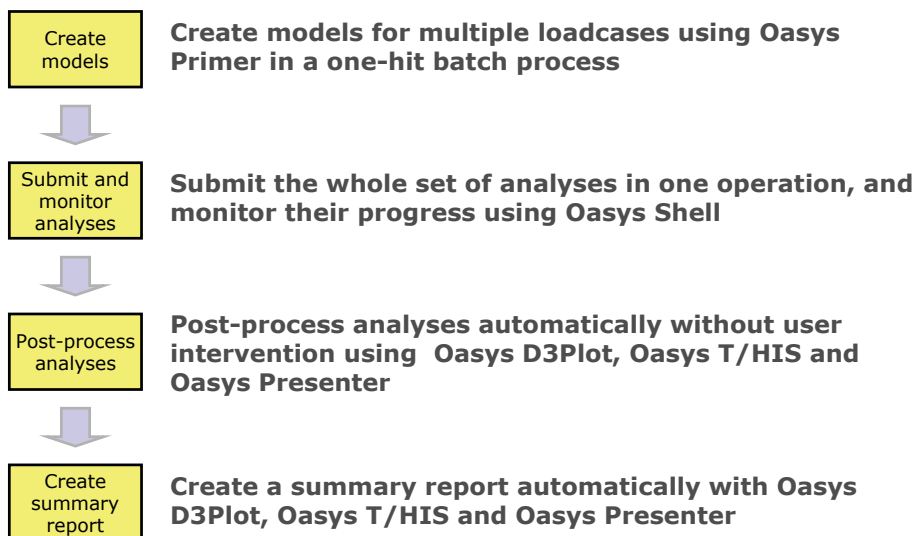


This paper shows software capabilities that are currently under development, and will be released in Version 9.2 later in 2005.

European LS-DYNA Conference 2005

ARUP

We want to do this automatically:



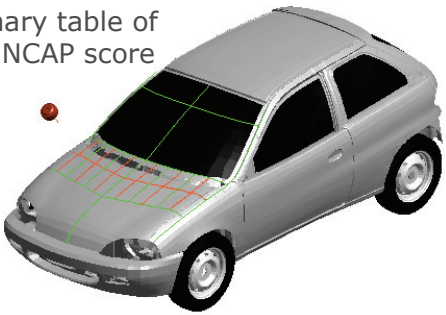
European LS-DYNA Conference 2005

ARUP

Example 1: Pedestrian analysis Objective

- Create models
- ↓
- Submit and monitor analyses
- ↓
- Post-process analyses
- ↓
- Create summary report

- Start from a list of impact points
- Automatically:
 - Position head & assemble models
 - Submit to LS-DYNA
 - Post-process each analysis
 - Generate a summary table of results; calculate NCAP score

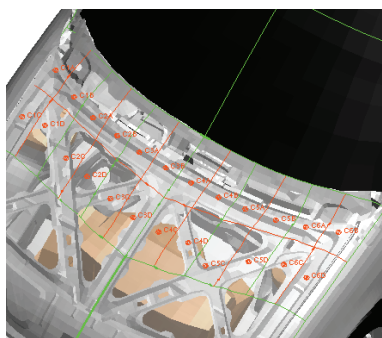


European LS-DYNA Conference 2005
ARUP

Example 1: Pedestrian analysis

- Create models
- ↓
- Submit and monitor analyses
- ↓
- Post-process analyses
- ↓
- Create summary report

- Target file allows Primer to create multiple analysis files with one click



```

                    Target file  Vehicle  Headform
                    |           |           |
                    v           v           v
                    +-----+
                    | Primer |
                    +-----+
                    | Key list | Run1.key | Run2.key | Run3.key |
                    +-----+-----+-----+
                    |                                         |
                    | Type, PEDHEAD                               |
                    | Model, /data/PEDHEAD/biw.key              |
                    | Impactor, /data/child_head.key            |
                    | Orient, node 1, node 2                    |
                    | Name, childhead                            |
                    | C1A, 900, 1393                             |
                    | C1B, 841, 1276                             |
                    | C1C, 694, 1399                             |
                    | C1D, 703, 1309                             |
                    | ...etc                                     |
                    +-----+-----+-----+
                    |                                         |
                    | Target zone name, X Y coords                |
                    +-----+-----+-----+
                    |                                         |
                    | Target file                                |
                    +-----+-----+-----+
                
```

- Primer automatically depenetrates the head

European LS-DYNA Conference 2005
ARUP

Example 1: Pedestrian analysis

Oasys Shell can now submit a list of jobs simultaneously and monitor the status of them.

European LS-DYNA Conference 2005

ARUP

Example 1: Pedestrian analysis

- After the analysis has finished, the shell automatically runs Presenter to post-process the analysis

Presenter then uses the report template to create a report for each analysis.

European LS-DYNA Conference 2005

ARUP

Example 1: Pedestrian analysis

- Presenter can be used to create a report template. This only has to be done once. The template is then reused for each analysis

Create models

↓

Submit and monitor analyses

↓

Post-process analyses

↓

Create summary report

Fast-TCF script to obtain acceleration and HIC.

D3Plot cut-section plot centred on impact location

The screenshot shows the Presenter software interface. The main window displays a script with variables like %PRESENTER_DEFAULT_DIR%, %X%, %Y%, %Z%, and %HIC_VALUE%. A red box labeled 'Variables' points to these variables. Below the script, there are two preview windows: 'FAST-TCF' and 'D3Plot'. A red arrow points from the 'D3Plot' preview to the text 'D3Plot cut-section plot centred on impact location'. The status bar at the bottom indicates 'Pedestrian head impact' and 'Test Zone: %ZONE%'.

European LS-DYNA Conference 2005 ARUP

Example 1: Pedestrian analysis

- When the report is generated, T/HIS and D3Plot are automatically run.

Create models

↓

Submit and monitor analyses

↓

Post-process analyses

↓

Create summary report

Output can be saved as:

- html
- postscript
- pdf
- vba macro or printed

The screenshot shows the Presenter software interface displaying a report. The main window shows job details: JOB NAME: /data/DEMO/CONFERENCE/PEDESTRIAN_HEAD/NCAP_RUNS_2/C8B, TARGET COORDS: 893.837, 185.963, 892.941, TERMINATION: Normal, HIC VALUE: 4326.915. Below the text, there is a graph titled 'CHIEF HEAD' showing acceleration over time, and a 3D model of a pedestrian head impact. A red box highlights the graph and model. The status bar at the bottom indicates 'Pedestrian head impact' and 'Test Zone: C8B'.

European LS-DYNA Conference 2005 ARUP

Example 1: Pedestrian analysis

A table is automatically generated from the results.

Each column contains the values of a variable selected by the user; each row corresponds to one analysis.

Conditional formatting is applied to highlight points where the result is poor.

ZONE	X	Y	Z	HIC
C1A	899.984	1393.17	895.182	4666.223
C1B	841.037	1276.24	896.854	1055.947
C1C	694.404	1399.28	851.726	343.4052
C1D	703.138	1308.79	881.869	627.7126
C2A	804.945	1171.9	898.937	476.1642
C2B	788.008	1057.62	903.647	467.8154
C2C	633.51	1172.65	856.931	606.6851
C2D	535.104	1077.06	838.169	733.6432
C3A	772.56	953.729	904.899	379.0345
C3B	769.51	839.023	907.352	370.9937
C3C	579.292	948.098	858.064	660.1346
C3D	510.226	839.023	842.116	3608.471
C4A	768.078	730.115	906.851	395.2333
C4B	772.701	616.895	904.472	445.4858
C4C	537.226	730.115	889.535	1523.748
C4D	554.485	617.219	850.258	2905.247
C5A	785.903	511.515	902.212	546.726
C5B	808.982	397.241	898.659	654.2155
C5C	542.836	518.655	841.1	3008.552
C5D	517.51	411.491	823.858	1326.146
C6A	845.074	292.893	896.995	1320.403
C6B	893.837	185.963	892.941	4326.915
C6C	691.625	283.66	859.93	792.093
C6D	694.404	189.853	852.004	1293.325

European LS-DYNA Conference 2005

Example 1: Pedestrian analysis

A user-supplied script has been employed here to calculate NCAP score for the child head impact zones.

Scripts can perform mathematical and logical operations based on values in Presenter Variables, which in turn are extracted automatically from the analysis results.

ZONE	NCAP CHOICES	YOU CHOOSE	YOU SCORE
C1	B	BCD	1.26
	C	CD	1.84
	D	NONE	2.00
	NONE	NONE	2.00
C2	A	NONE	2.00
	B	NONE	2.00
	C	NONE	2.00
	D	NONE	2.00
C3	A	NONE	2.00
	B	NONE	2.00
	C	NONE	2.00
	D	NONE	1.50
C4	A	NONE	2.00
	B	NONE	2.00
	C	AB	1.00
	D	AB	1.00
C5	A	NONE	2.00
	B	NONE	2.00
	C	AB	1.00
	D	AB	1.00
C6	A	C	0.63
	B	C	0.50
	C	NONE	2.00
	D	C	0.74

SUMMARY: NCAP CHOSES QUARTILE WITH WORST HIC

C1	A	BCD	1.26
C2	D	NONE	2.00
C3	D	ABC	1.50
C4	D	AB	1.00
C5	C	AB	1.00
C6	B	C	0.50

Total points of maximum12: 7.26

European LS-DYNA Conference 2005

Example 1: Pedestrian analysis

Create models

↓

Submit and monitor analyses

↓

Post-process analyses

↓

Create summary report

Presenter passes a list of coordinates and HIC values to D3plot. An image showing the HIC values at each impact location is automatically inserted into the report.

Several formats are available.

In the top image the value is given in a box coloured by HIC

In the bottom image the size of the circle is also proportional to the HIC value.

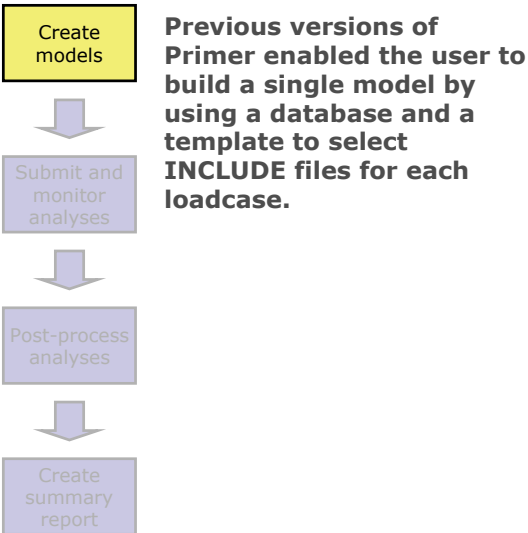
European LS-DYNA Conference 2005 ARUP

Example 2: Multiple crash cases

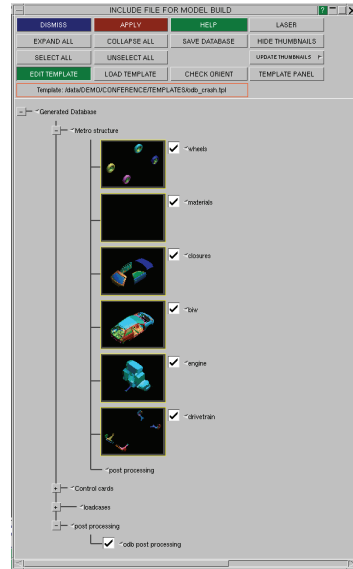
ECER32	ECER95	Euro NCAP	Euro NCAP	Euro NCAP	FMVSS208
FMVSS208	FMVSS214	FMVSS214	FMVSS216	FMVSS301	IIHS
IIHS	Jap NCAP	Jap NCAP	Jap NCAP	US NCAP	US NCAP

European LS-DYNA Conference 2005 ARUP

Example 2: Multiple crash cases



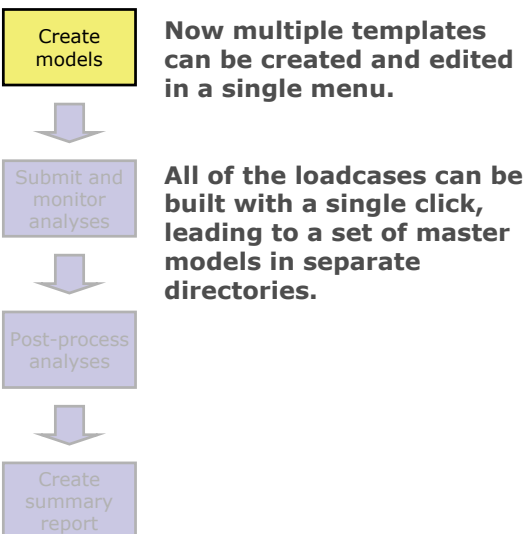
Previous versions of Primer enabled the user to build a single model by using a database and a template to select **INCLUDE** files for each loadcase.



European LS-DYNA Conference 2005

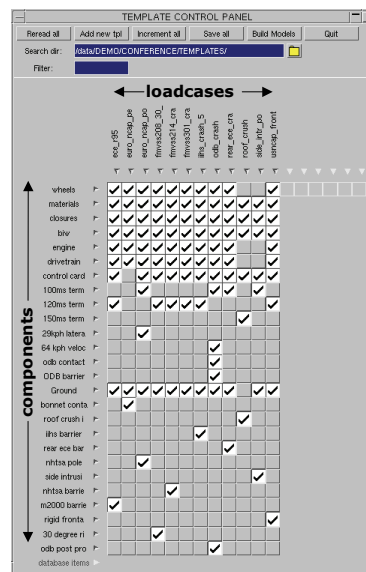


Example 2: Multiple crash cases



Now multiple templates can be created and edited in a single menu.

All of the loadcases can be built with a single click, leading to a set of master models in separate directories.



European LS-DYNA Conference 2005



Example 2: Multiple crash cases

Individual Presenter templates are used for each loadcase to extract the relevant data. e.g. ODB

Create models

↓

Submit and monitor analyses

↓

Post-process analyses

↓

Create summary report

Fast-TCF script to obtain steering column motion

```

Program: FAST-TCF
Filetype: Bitmap
Filename: %PRESENTER_DEFAULT_DIR%/steering
Job file: %PRESENTER_DEFAULT_DIR%/PRESENTER
FAST-TCF script
# Program: FAST-TCF
# Filetype: Bitmap
# Filename: steering_col.bmp
# Job file: /data/DEMO/CONFERENCE/ODB_AM
#
model 2
spring 40000110 e tag curve_1 yscale -1
spring 40000111 e tag curve_2 label Upwa
#
# Curve Style definitions
style one solid white hold triangle
style two solid white hold triangle
style three solid white hold triangle
#
# Max rear displacement = %ST_COL_REAR%
# Max rear displacement modifier = %ST_COL_REAR_MOD%
#
# Max upwards displacement = %ST_COL_UP%
# Max upwards displacement modifier = %ST_COL_UP_MOD% points
#
# Max lateral displacement = %ST_COL_LAT%
# Max lateral displacement modifier = %ST_COL_LAT_MOD% points
    
```

Fast-TCF script to obtain A-pillar displacement

```

Program: FAST-TCF
Filetype: Bitmap
Filename: %PRESENTER_DEFAULT_DIR%/a_pill.o
Job file: %PRESENTER_DEFAULT_DIR%/PRESENTER
FAST-TCF script
# Program: FAST-TCF
# Filetype: Bitmap
# Filename: a_pill_disp.bmp
# Job file: /data/DEMO/CONFERENCE/ODB_AM
#
model 2
spring 40000113 e yscale -1 tag curve_1
#
# Curve Style definitions
style one solid white hold triangle
#
# Max displacement = %A_PILLAR_DISP%
# Max displacement modifier = %A_PILLAR_MOD%
#
# Max rear displacement = %ST_COL_REAR%
# Max rear displacement modifier = %ST_COL_REAR_MOD%
#
# Max upwards displacement = %ST_COL_UP%
# Max upwards displacement modifier = %ST_COL_UP_MOD% points
#
# Max lateral displacement = %ST_COL_LAT%
# Max lateral displacement modifier = %ST_COL_LAT_MOD% points
    
```

Presenter scripts process information

European LS-DYNA Conference 2005 ARUP

Example 2: Multiple crash cases

Generated report for ODB with results calculated

Create models

↓

Submit and monitor analyses

↓

Post-process analyses

↓

Create summary report

Presenter scripts have calculated NCAP modifiers from data

Displacement of the steering column

Max rear displacement = 173.2991
 Max rear displacement modifier = 1 points

Max upwards displacement = 35.74585
 Max upwards displacement modifier = 0 points

Max lateral displacement = 12.59571
 Max lateral displacement modifier = 0 points

Displacement of the A-Pillar

Max displacement = 197.2246
 Max displacement modifier = 1.944492 points

Euro NCAP report page 3 of 4

European LS-DYNA Conference 2005 ARUP

Example 2: Multiple crash cases

Generated report for ODB with total modifier and analysis quality

Create models

↓

Submit and monitor analyses

↓

Post-process analyses

↓

Create summary report

In house criteria: pass/fail from user-supplied script

Quality of the analysis (in this case, "Not OK" because of energy imbalance)

Modifier calculated by Presenter

European LS-DYNA Conference 2005 ARUP

Example 2: Multiple crash cases

Create models

↓

Submit and monitor analyses

↓

Post-process analyses

↓

Create summary report

The quality of the analysis is determined by a (customisable) script in Presenter, using energy balance, termination and added mass.

Normal termination check

Added mass check

Energy checks

Argument	Value
1	OTF file name
2	normal termination (false = no check)
3	% added initial mass limit (false = no check)
4	% added final mass limit (false = no check)
5	% total energy fluctuation limit (false = no check)
6	% hourglass energy limit (false = no check)

European LS-DYNA Conference 2005 ARUP

Example 2: Multiple crash cases



A table is automatically generated for all the crash cases, giving the analysis quality and pass/fail criteria.

Conditional formatting is applied to highlight crash cases where the performance criteria were not met.

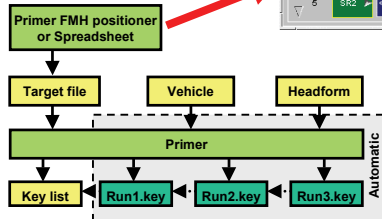
Description	Pass or Fail	Quality of run
QDB 64kwh Drivers Side	fail	Not OK
Euro NCAP QDB Passengers Side	pass	OK
Euro NCAP pole	fail	OK
Euro NCAP side impact	pass	OK
ECER32	fail	Not OK
ECER95	pass	OK
FMVSS206 frontal	pass	OK
FMVSS206 30 degree frontal	pass	OK
FMVSS214 Side impact	pass	OK
FMVSS214 Door intrusion	pass	Not OK
FMVSS216	pass	OK
FMVSS301 fuel integrity	pass	OK
IIHS offset barrier	fail	OK
IIHS side impact	fail	Not OK
Jap NCAP offset barrier	fail	OK
Jap NCAP side impact	pass	OK
US NCAP front impact	fail	Not OK

Example 3: Interior head impact



Target file can be written from Primer (or from a spreadsheet) to allow all analyses to be submitted and processed in a similar way to pedestrian analyses described earlier

Label	Posn	Name	X	Y	Z	Min	Max	ON
1	AP1	<title>	2747.0	-520.1	1288.9	0.0	360.0	ON
2	AP2	<title>	2879.4	-568.4	1181.9	0.0	360.0	ON
3	AP3	<title>	3005.1	-503.8	1098.3	0.0	360.0	ON
4	SR1	<title>	2503.9	-467.0	1362.6	0.0	360.0	ON
5	SR2	<title>	2323.4	-468.4	1388.4	0.0	360.0	ON



Example 3: Interior head impact

Presenter and D3Plot automatically generate plot showing HIC values for each location.

0.000
0.750
1.000
5.000
x 1.0E+03

FAST TCF

European LS-DYNA Conference 2005

ARUP

Example 3: Interior head impact

A table is automatically generated, containing one row per analysis; here, the table has been set up to show analysis quality and HIC.

Target Point	Quality	HIC
AP1	OK	1250
AP2	OK	625
AP3	OK	650
BP1	OK	725
BP2	OK	1100
BP3	OK	875
BP4	OK	660
FH1	OK	625
RH1	OK	625
RP1	OK	650
SR1	OK	675
SR2	OK	680
SR3	OK	675
UR1	OK	575
UR2	OK	675
UR3	OK	675
UR4	OK	675

FMVSS201 report page 2 / 2

European LS-DYNA Conference 2005

ARUP

Summary and Conclusions

- **Three examples of automatic processes for multiple analyses have been shown.**
 - Pedestrian bonnet impact
 - Multiple crash loadcases
 - Interior head impact
- **Using Oasys Primer, Shell, D3Plot, T/HIS and Presenter, the man-time taken to process multiple analyses can be reduced from days to a few minutes.**
- **Any type of repetitive analysis process with LS-DYNA can be automated in this way, including user-generated scripts where needed**
- **The software capabilities described in this paper are under development, and will be released with version 9.2 later this year.**

European LS-DYNA Conference 2005

ARUP

Automatic processes for multiple analyses

4th German LS-DYNA Forum 2005

Miles Thornton

Christopher Bell, David Burton, Paul Davidson,
Ben Dennis, Roger Hollamby, Richard Sturt

Correspondence:

Miles Thornton
The Arup Campus
Blythe Gate, Blythe Valley Park
Solihull, W.Midlands B90 8AE
Tel: +44 (0)121 213 3399
Fax: +44 (0)121 213 3302
dyna.support@arup.com

ARUP

