

Automation with Vampire

A case study on wagon imbalanced loading

Vampire User Day

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Phil Shackleton

A need for automation

- Repetitive tasks
 - Large number of cases
 - e.g. parametric study
 - Longer term efficiency
 - Multiple occasions/repeat jobs
 - Repeatability
 - Reduced user error
- Vampire includes tools...
 - Command file
 - *PARAMETER
 - Task files .vtf*
- Here we take a look at some of those and other possibilities beyond

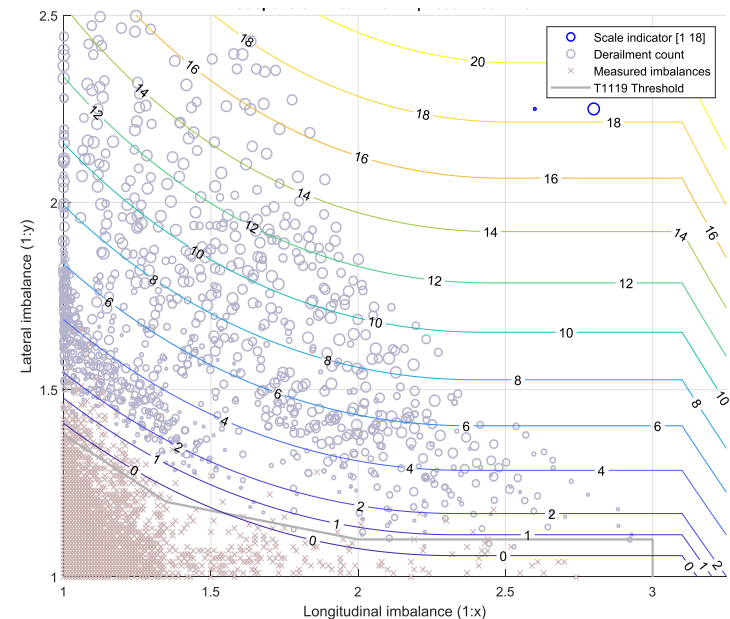
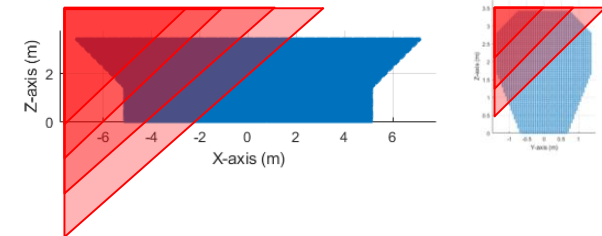
The screenshot shows the Vampire software interface. The main window displays a command file named 'GMRT2141_YQ_YSeries8p5_H_Veh_001.vac'. The file content includes a header, commands, and a parameter section. The parameter section lists various physical parameters such as BogSemSpac, BogSemWhl, BodyMass, BodyIxx, BodyIyy, BodyIzz, BodyPosX, BodyPosY, and BodyPosH. A second window, 'CSVExport.vtfEXP', is open in the foreground, showing an application configuration for exporting data to a CSV file. The application name is 'Export Utility', and it includes settings for the run file, speed, condition, and output format.

```
1 [Header]
2 FileType = VampireCommandFile
3 [Commands]
4 TaskNumberOff
5 ; #####
6 %vehicle% = ../../../../VLIB/YSeries8p5 H Models/YSeries8p5
7 %dt_ip4f% = 0.0005
8 ; #####
9 File = ../../../../Templates/AppC_YQ_template.run
10 %flead% = 10.6572
11 %ftrail% = 10.65
12 ; ****
13 %irreg% *PARAMETER
14 %design% **
15 %profil% BogSemSpac = 8.0
16 %gauge% BogSemWhl = 1.3
17 Replace BodyMass = 30.0
18 Task = BodyIxx = 35.0
19 Go BodyIyy = 1000.0
20 ; **** BodyIzz = 1000.0
21 %irreg% BodyPosX = -0.5
22 %design% BodyPosY = -0.15
23 %profil% BodyPosH = 1.57
24 %gauge% *MASS
25 Replace INERTIA
26 Task = M1 POSIT
27 Go
28 ; ****
29 %irreg% = ../../../../
30 %design% = ../../../../
31 %profile% = ../../../../
32 %gauge% = 9
33 ReplaceTo = V-YSeries8p5
34 Task = V-YSeries8p5 H
```

```
1 [Application]
2 ProgramName=Export Utility
3
4 [Export]
5 RunFile =%RunFileName%
6 Speed =5.0
7 Condition=Variable
8 Line1 =1
9 Line2 =2
10 Line3 =3
11 Line4 =4
12 Line5 =5
13
14 [Output]
15 Type =Ascii
16 Format =Auto
```

Case study context

- Influence of imbalance loading on derailment risk
 - Study was carried out through several projects from 2017 to 2019
- Container and bulk wagons
 - 1950 payload cases
 - 8 different wagon/suspension types
 - Circa 7000 individual vehicle models
 - Simulation cases:
 - Wheel unloading
 - Bogie rotational resistance
 - Resistance to flange climb
 - Total of around 140,000 simulations
- Output trend between imbalance and derailment resistance

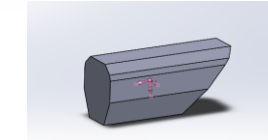


Vehicle model configuration

- A range of payloads
 - Include effects on suspension characteristics and initial conditions
- ***PARAMETER**
 - For a parametric study model values can be changed using vac ReplaceTo
- Vehicle models are text so generation is straightforward
 - Write whole vehicle file or update ***PARAMETER** section
 - Excel, Matlab, Python, batch file etc.

```

11 *****
12 *PARAMETER
13 *****
14 **
15 BogSemSpac = 8.0
16 BogSemWhl = 1.3
17 BodyMass = 30.0
18 BodyIxx = 35.0
19 BodyIyy = 1000.0
20 BodyIzz = 1000.0
21 BodyPosX = -0.5
22 BodyPosY = -0.15
23 BodyPosH = 1.57
24 **
25 *****
26 *MASS
27 *****
28 **
29 INERTIA BodyMass BodyIxx BodyIyy BodyIzz
30 POSITION BodyPosX BodyPosY BodyPosH
31
32
33
    
```



	A	B	C	D	E	F	G	H	I
25	*****								
26	*MASS								
27	*****								
28	**								
29	INERTIA		30	=1/12*C29*((G31-D31)^2+(H31-E31)^2)					
30	M1	POSITION	-0.5	-0.15	1.57				
31		SIZE	-11.5	-1.35	1.02	11.5	1.35	3.57	
32									
33									

```

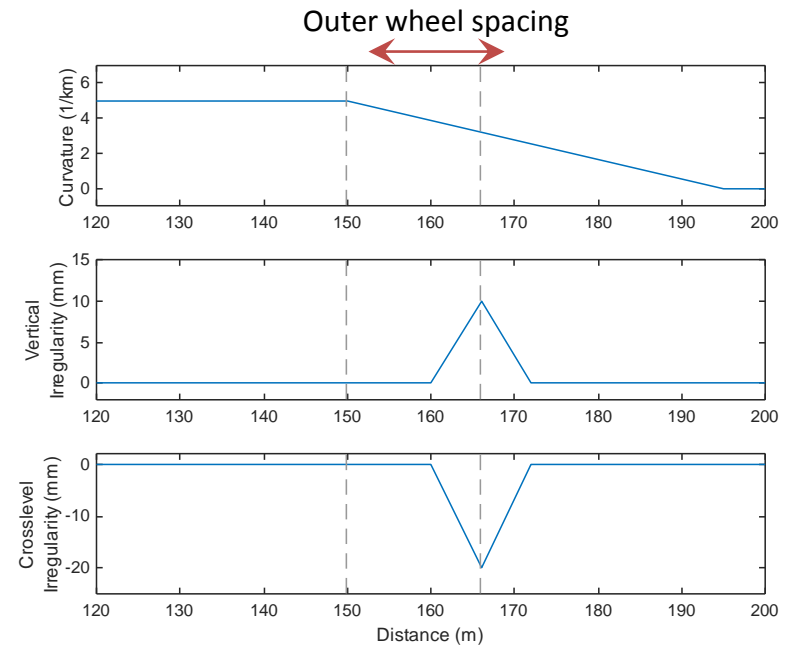
(V)
(General) SaveSheetAs
Sub SaveSheetAs ()
|
Dim wb As Workbook
' Disable saving prompts (overwrite etc.)
Application.ScreenUpdating = False
Application.DisplayAlerts = False

' Get current workbook path
homeDir = ActiveWorkbook.Path

' Loop through all the vehicle models
For iCounter = 1 To 248

Sheets("Input Data").Range("C6").Value = iCounter
    
```

- Track file generation
 - E.g. dip position on Y/Q assault course
 - Vehicle model files can be read as easily as written
 - Identify ***WHEELSET** and **POSITION**
 - Extract required dimensions
 - Vehicle type specific track files can be written as .dat or .csv



Vehicle file excerpt

```
71 *****
72 *WHEELSET
73 *****
74 **
75 ..... INERTIA 1.12 0.73 0.03
76 M3 POSITION BogSemSpac+BogSemWhl 0.0 0.45
77 **
78 ..... INERTIA 1.12 0.73 0.03
79 M4 POSITION BogSemSpac-BogSemWhl 0.0 0.45
80 **
```

- Usersub e.g. used to simulate laboratory tests
 - Wheel unloading and rotational resistance
 - Where case specific Usersub parameter is needed
 - *USER lines in run file
 - Values could be read from vehicle file
 - Where the Usersub function changes
 - Source code is written programmatically
 - Compiler called (with switches and dependencies) to generate Usersub.dll on the fly

Run file excerpt

```
15 *CREEP
16 *****
17 | | | ...
18 **
19 *USER
20 ** Bogie pivot spacing read by usersub (m)
21 8.5
22 ** Bogie wheelbase read by usersub (m)
23 1.83
24 *OUTPUT
25 *****
26 | | | ...
27 **
```

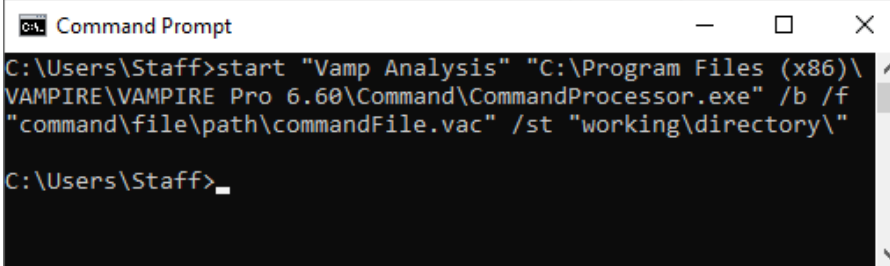
Fortran Usersub source code

```
93 C Get the bogie centres from the user input line 1
94 CALL VTEUGetUserData(1, USERLINE1,80,IERR)
95 READ(USERLINE1 , *) CENTRES
96 C (m) **
97 C
98 C Get the bogie wheelbase from the user input line 2
99 CALL VTEUGetUserData(2, USERLINE2,80,IERR)
100 READ(USERLINE2 , *) WHEELBASE
```

Compiler call from Matlab

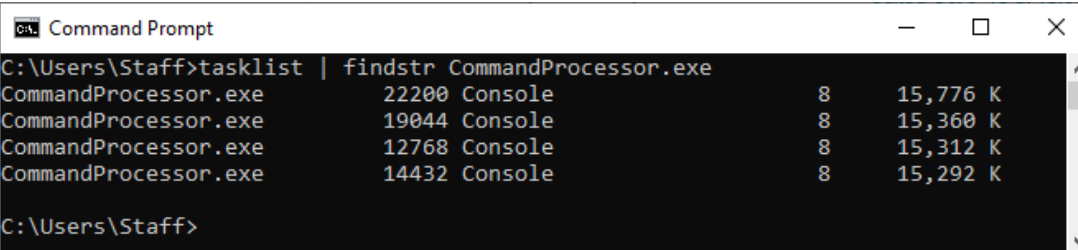
```
- | % Call the Watcom compiler
  | if ~system(['wfc386 ' c1szUserSubs{i} '.for -incp=C:\Users\Public\DOCUME...
  | ~system(['wlink name ' c1szUserSubs{i} '.dll SYS nt_dll libr kernel...
```

- Vampire solvers can be launched from the command line
 - Programmatically e.g. with 'system' call (from Matlab) or equivalent
 - Call the transient solver with a [transient] run file
 - Call the command processor with a vac file



```
C:\Users\Staff>start "Vamp Analysis" "C:\Program Files (x86)\VAMPIRE\VAMPIRE Pro 6.60\Command\CommandProcessor.exe" /b /f "command\file\path\commandFile.vac" /st "working\directory\"  
C:\Users\Staff>_
```

- Parallel processing (without Run Control)?
 - Launch multiple instances
 - Query the number of processes running from the OS [e.g. with 'tasklist' on windows]
 - Manage CPU load within a logic loop and maximum number of instances



```
C:\Users\Staff>tasklist | findstr CommandProcessor.exe  
CommandProcessor.exe      22200 Console           8      15,776 K  
CommandProcessor.exe      19044 Console           8      15,360 K  
CommandProcessor.exe      12768 Console           8      15,312 K  
CommandProcessor.exe      14432 Console           8      15,292 K  
C:\Users\Staff>
```

- Thousands of .out files alone are not so useful...
- lis and log files are text and can be parsed
 - E.g. extract warnings and lis file statistics
- out files are binary, but 32 bit floating point data can be read
 - Matlab, Python, Excel macro
- Alternatively, use vtfexp to convert out files to csv in the command loop

```
202 *
203 *MAX DATA:-
204 CH 1 Body 1 datum sway @bogie 1 mm
205 8.128E-03
206 CH 2 Body 1 datum sway @bogie 2 mm
207 4.962E-05
208 CH 3 Body 2 datum sway @bogie 2 mm
209 5.115E-05
210 CH 4 Body 2 datum sway @bogie 3 mm
211 3.648E-01
```

```
CSVExport.vtfEXP x
1 [Application]
2 ProgramName=Export Utility
3
4 [Export]
5 RunFile =%RunFileName%
6 Speed =5.0
7 Condition=Variable
8 Line1 =1
9 Line2 =2
10 Line3 =3
11 Line4 =4
12 Line5 =5
13
14 [Output]
15 Type =Ascii
16 Format =Auto
```


- Vampire includes a range of tools to assist automation
- The Vampire file types and installation allows many more possibilities for user automation
- Powerful toolboxes can be built to
 - Expand parametric studies
 - Improve repeatability
 - Streamline repetitive tasks

The screenshot displays three overlapping windows from the Vampire software environment:

- Command Prompt:** Shows the execution of a Vampire analysis command. The output includes a table of data for different bogie configurations:

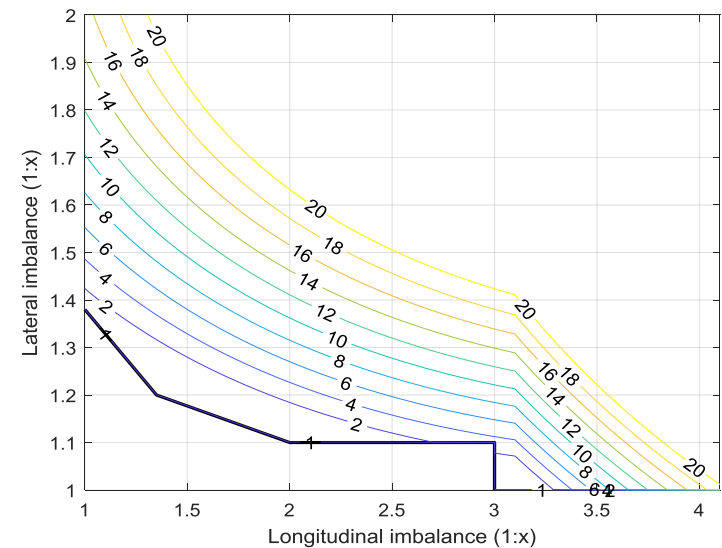
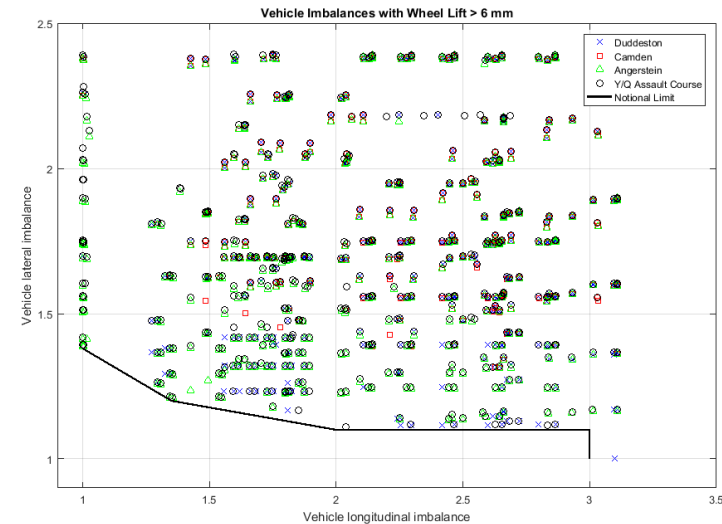
CH	Body	datum sway	Value
1	Body 1	datum sway @bogie 1	8.128E-03
2	BogW 1	datum sway @bogie 2	4.962E-05
3	BogW 2	datum sway @bogie 2	5.115E-05

- Spreadsheet:** Shows a table with columns A through I. Row 29 contains a formula for INERTIA: $30 = 1/12 * C29 * ((G31-D31)^2 + (H31-E31)^2)$. Row 30 shows POSITION values for M1, and row 31 shows SIZE values.
- Code Editor:** Displays a VBA macro named 'SaveSheetAs' with the following code:


```
Sub SaveSheetAs ()
    Dim wb As Workbook
    ' Disable saving prompts (overwrite etc.)
    Application.ScreenUpdating = False
    Application.DisplayAlerts = False
    ' Get current workbook path
    homeDir = ActiveWorkbook.Path
    ' Loop through all the vehicle models
    For iCounter = 1 To 248
        Sheets("Input Data").Range("C6").Value = iCounter
    
```

Summary

- Such tools were used to investigate the influence of imbalanced loading on derailment resistance
- Trends observed used to define:
 - Low derailment ‘threshold’
 - Derailment risk score
- Metrics are included in NR imbalance reports to help freight operators manage risk
- Threshold informed new testing conditions for intermodal wagons in GMRT2141 issue 4



Questions...