Automation with Vampire
A case study on wagon imbalanced loading

Vampire User Day

16th July 2020

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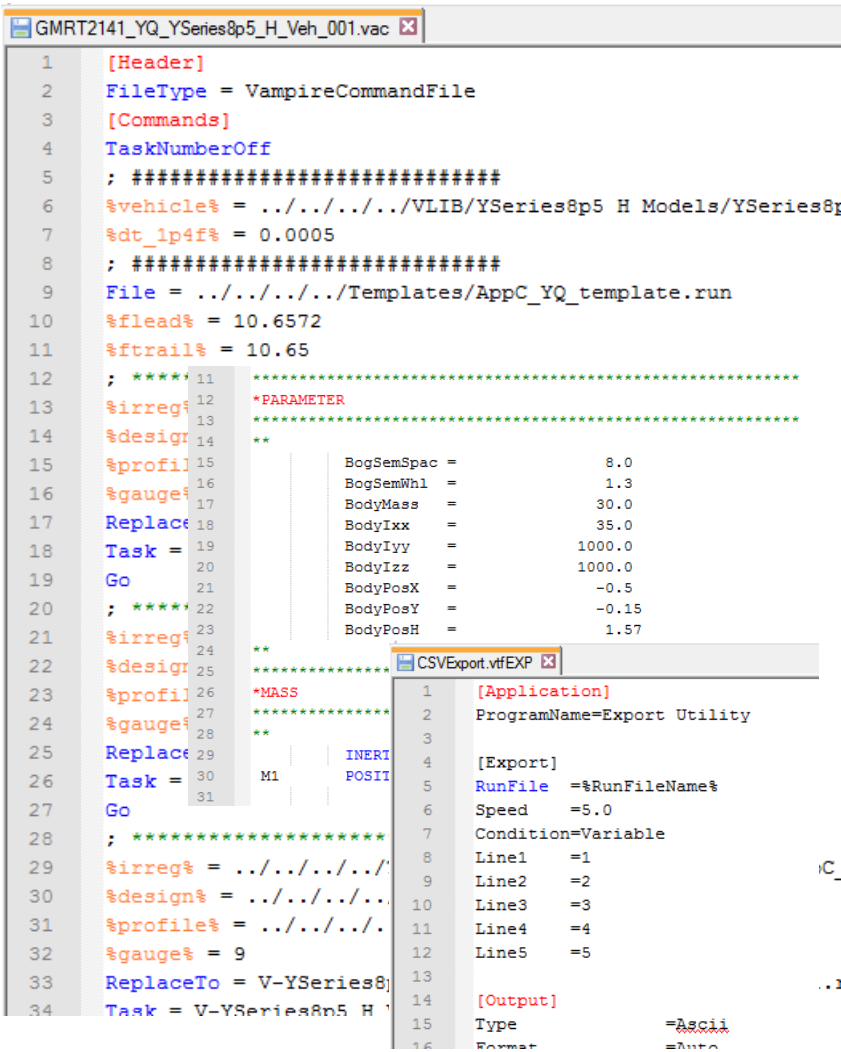
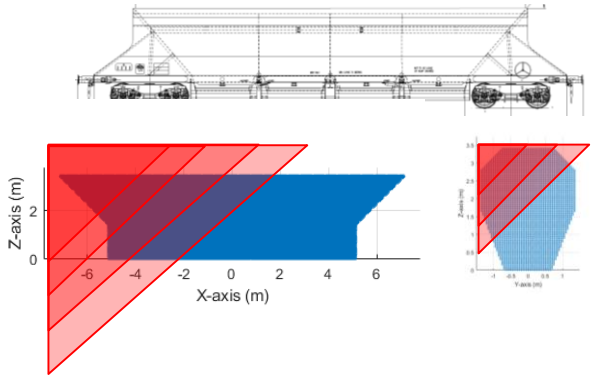
A need for automation

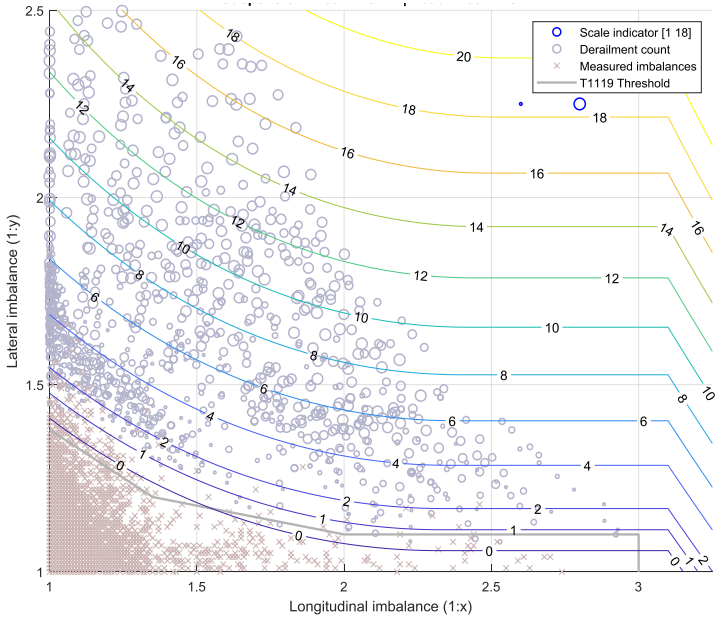
- Repetitive tasks
  - Large number of cases
    - e.g. parametric study
  - Longer term efficiency
    - Multiple occasions/repeat jobs
  - Repeatability
    - Reduced user error
- Vampire includes tools…
  - Command file
  - *PARAMETER
  - Task files .vtf*
- Here we take a look at some of those and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



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



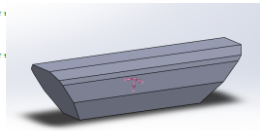


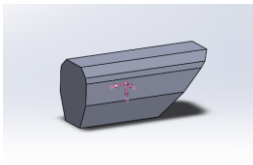
Vehicle model configuration

University of HUDDERSFIELD
Institute of Railway Research

- 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   M1       POSITION   BodyPosX   BodyPosY   BodyPosH
31
```





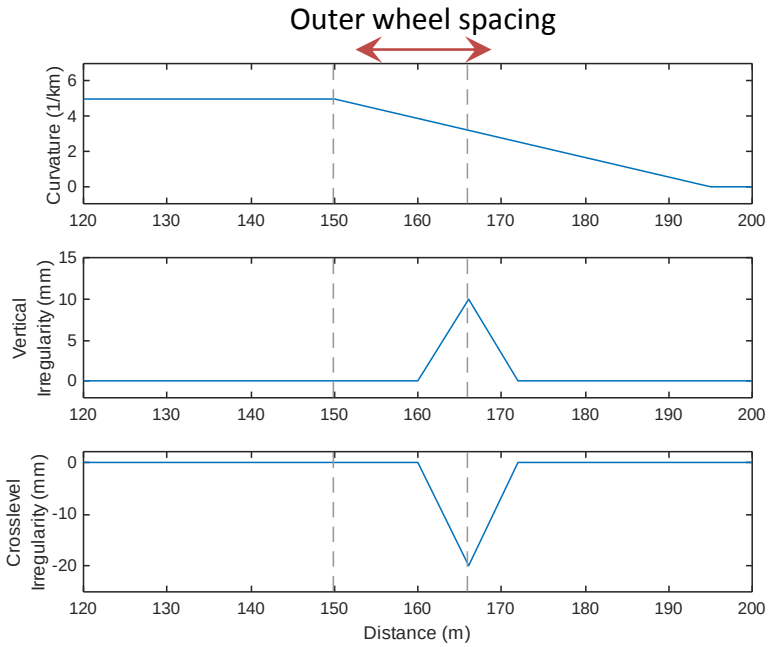
	A	B	C	D	E	F	G	H
25	**********							
26	*MASS							
27	**********							
28	**							
29		INERTIA	30	=1/12*C29*((G31-D31)^2+(H31-E31)^2)				
30	M1	POSITION	-0.5	-0.15	1.57			
31		SIZE	-11.5	-1.35	1.02	11.5	1.35	3.57
32								
33								

(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
```

Simulation environment

- 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  **
```

Simulation environment

- 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

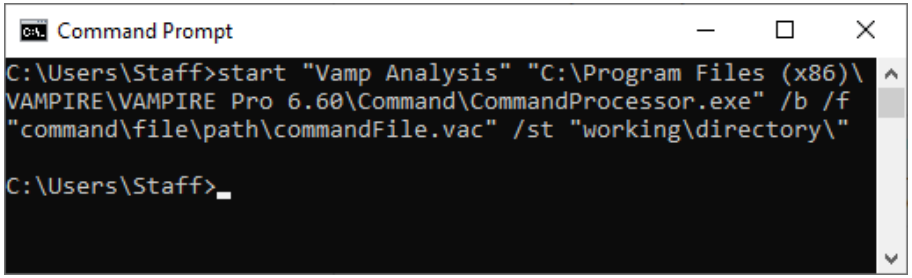
```
93  C     Get the bogie centres from the user input line 1
94        CALL VTEUGetUserData(1, USERLINE1,80,IERR)
95        READ(USERLINE1 , *) CENTRES
96  C     (m)                                    **
97  C
98  C     Get the bogie wheelbase from the user input line 2
99        CALL VTEUGetUserData(2,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

Compiler call from Matlab

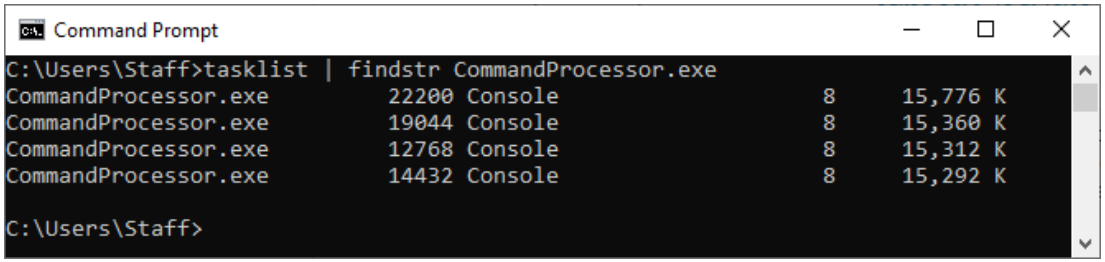
```
% Call the Watcom compiler
if ~system(['wfc386 ' c1szUserSubs{i} '.for -incp=C:\Users\Public\DOCUME...
        ~system(['wlink name ' c1szUserSubs{i} '.dll SYS nt_dll libr kernel...
```

Running simulations

- 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



- 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



Reading results

- 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

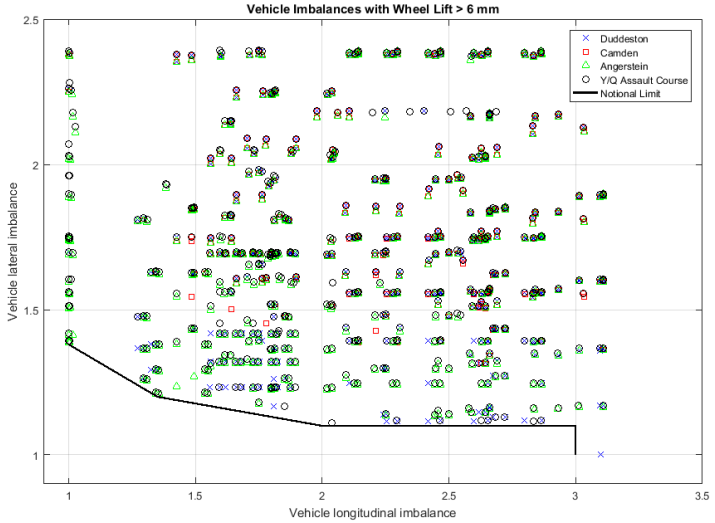
```
1   [Application]
2   ProgramName=Export Utility
3
4   [Export]
5   RunFile  =%RunFileName%
6   Speed    =5.0
7   Condition=Variable
8   Line1    =1
9   Line2    =2
10  Line3    =3
11  Line4    =4
12  Line5    =5
13
14  [Output]
15  Type                =Ascii
16  Format              =Auto
```

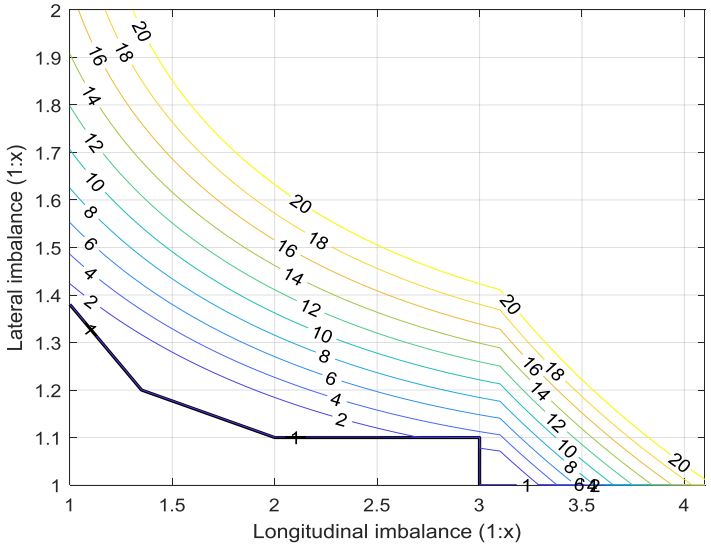
Summary

- 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

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…