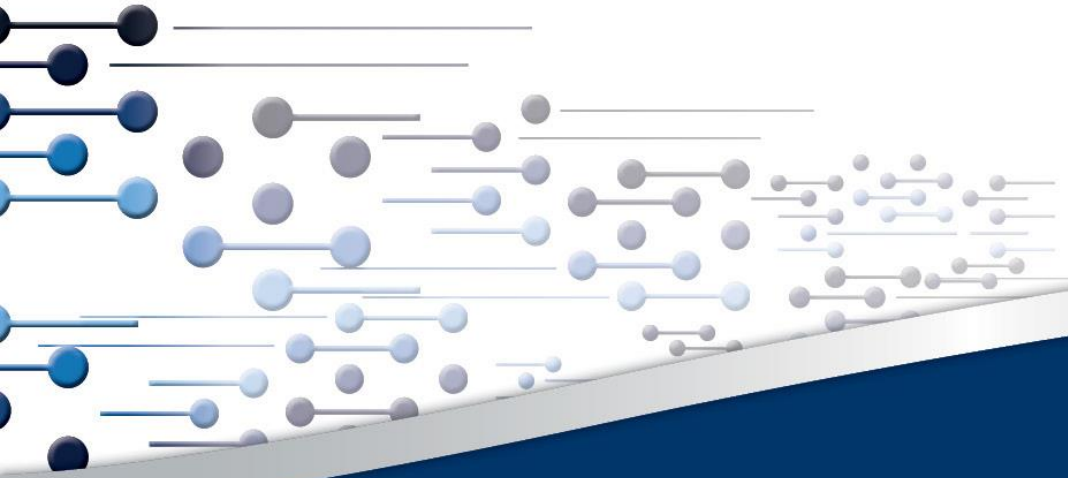
# Annex Q – CSIR – SOUTH AFRICAN MOBILITY PREDICTION SOFTWARE MOBSIM

**Note:** This Annex appears in its original format.

# South African Mobility Prediction Software MOBSIM

**NATO CSO CDT-308**
**Keweenaw Research Centre MI USA**
**25-27 September 2018**

JD Reinecke, D. Modungwa and P. Nkosi




# Contents

## Contents



ARMSCOR
Armaments Corporation of South Africa SOC Ltd

CSIR
our future through science

# 1 Introduction to Armscor and CSIR

Defence Evaluation and Research Institute (DERI)

- Armscor
  - Armscor Acquisition
  - Armscor R&D
- Council for Scientific and Industrial Research (CSIR)
  - Built environment (soils / hydrology, paving etc.), Natural Environment, Energy, Health, Industry (Mining, Advanced Manufacturing) and ***Defence Peace, Safety and Security***
- Industry (limited technology specific areas)
  - Denel (DLS (including Mechem, DVS, LMT), Aviation etc.)
  - Rheinmetall Denel Munition (RDM)

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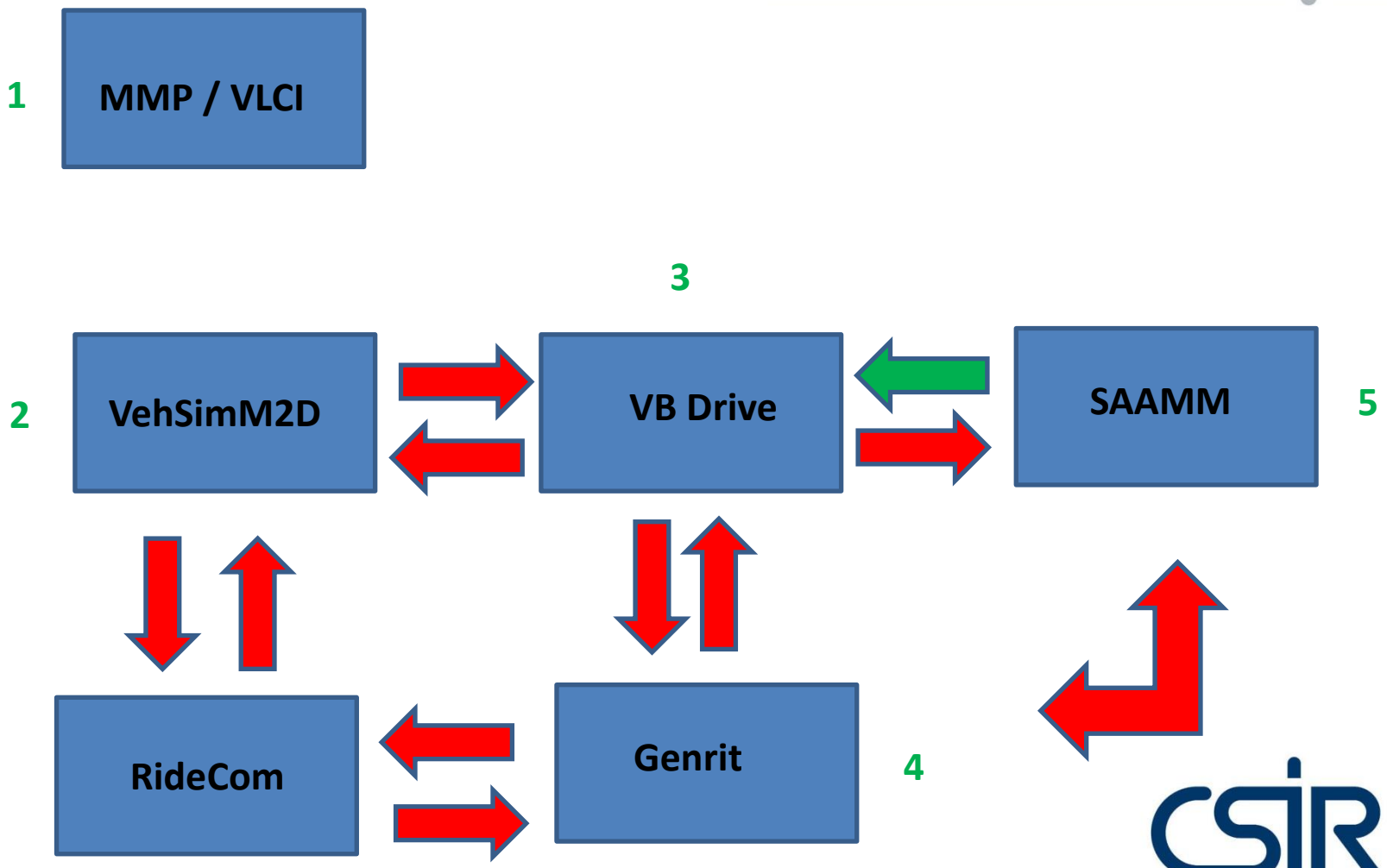
# 2 MOBSIM History

- Operational Guerrilla Warfare from 1960's
- Large number of landmine incidents (ca 1 000= pa)
- Developed local range of successful vehicles (Sanctions)
- Large mobility research effort from late 1970's to early 1990's
- Outputs Combined (MOBSIM) late 1990's and last update 2006

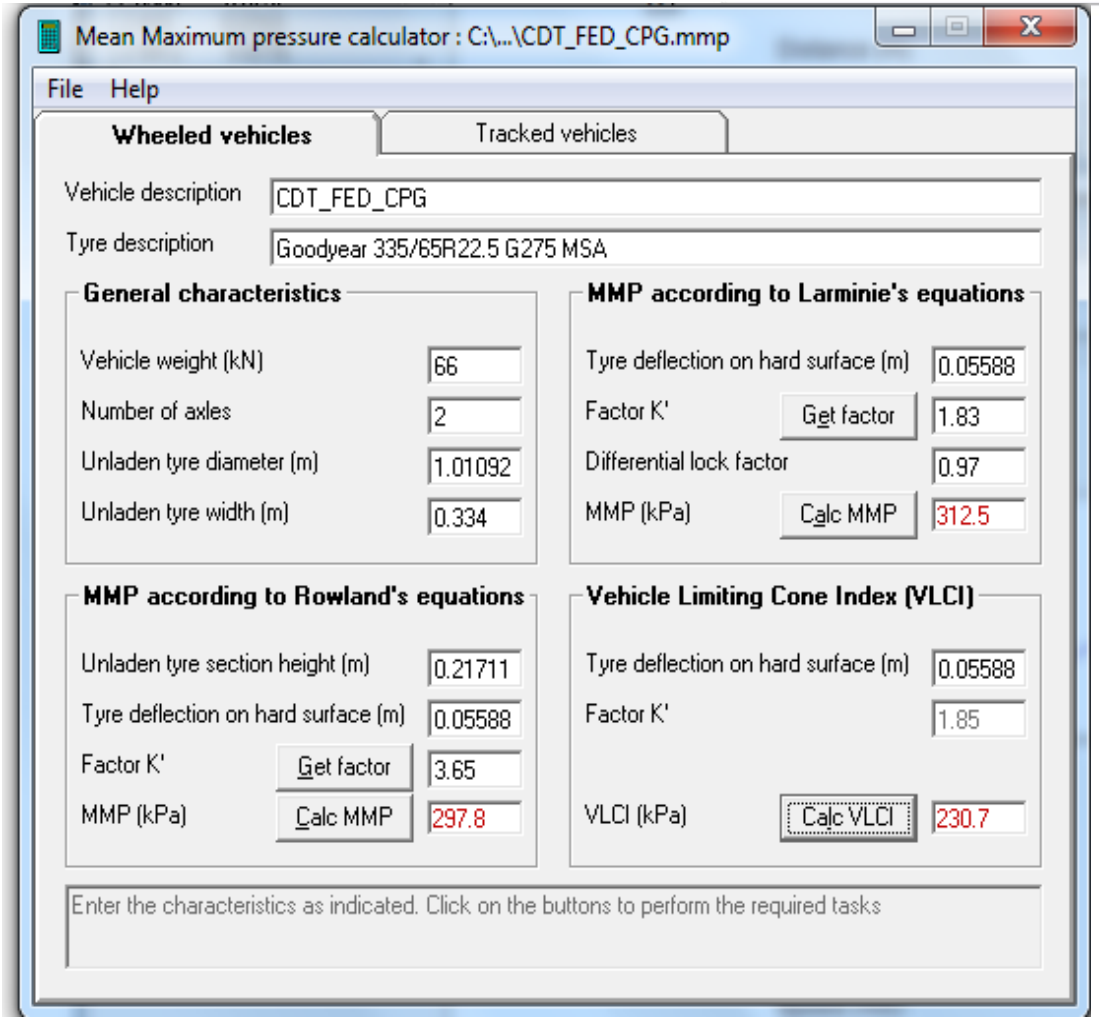

[https://www.google.co.za/search?q=south+african+mine+protected+vehicles&tbm=isch&source=iu&ictx=1&fir=YV2F7WYBdYj2OM%253A%252Ckyx4luZdkwyf6M%252C_&usg=AFrqEzdYtWOWm7I4BKQ-HxYybz_rGsP0TQ&sa=X&ved=2ahUKEwiTuIri3rXdAhUJJ8AKHY7MBYcQ9QEwA3oECAUQCg#imgrc=3ZJU_alf4APBMM:&spf=1536764741833]

# 3 MOBSIM Structure

# 3 MOBSIM Structure

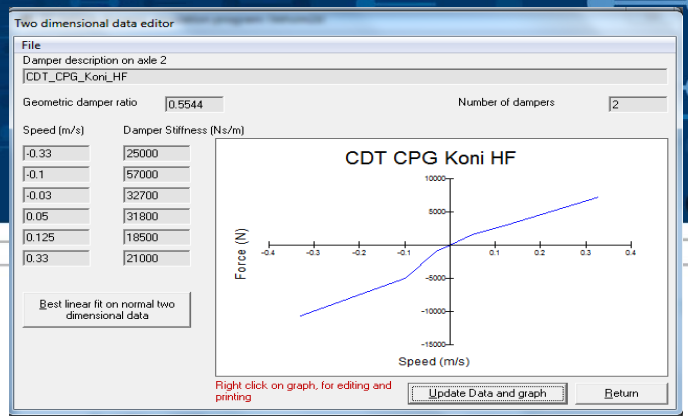


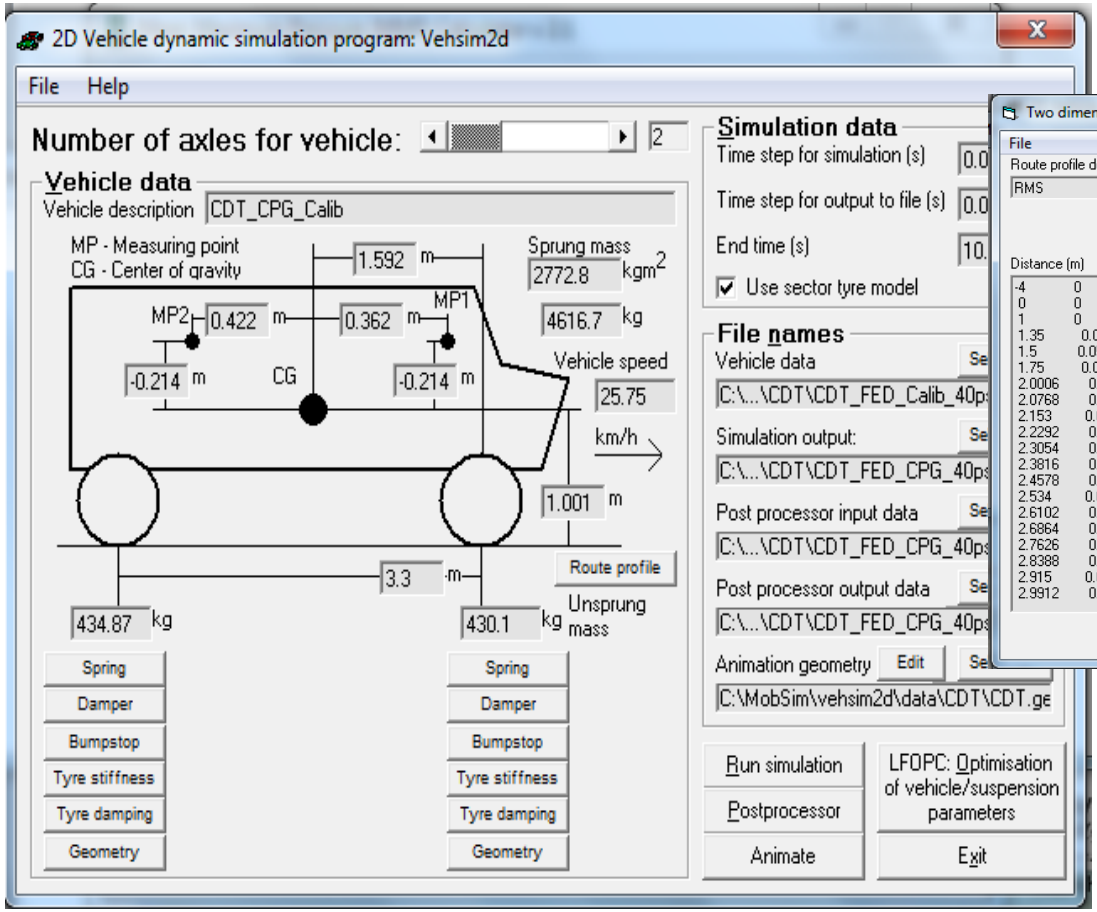
# 4. MMPSIM

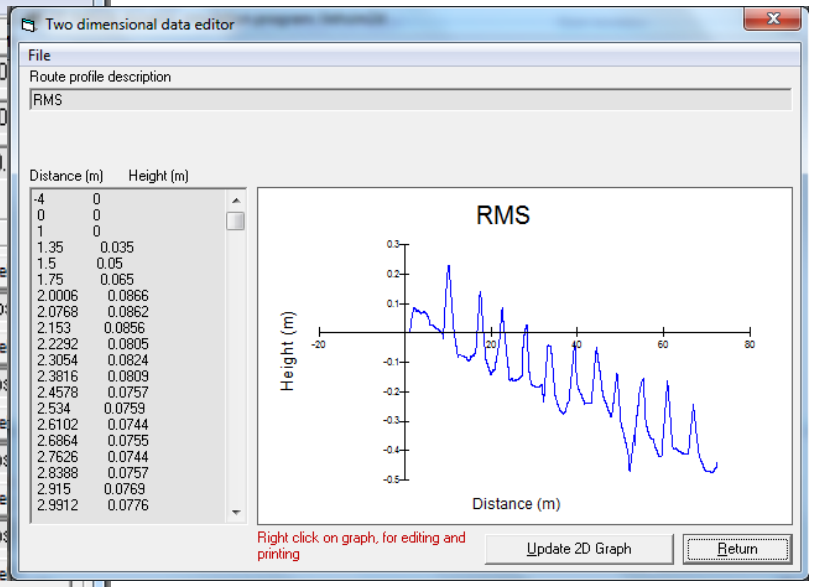

Mean Maximum pressure calculator : C:\...\CDT_FED_CPG.mmp
File
Help
Wheeled vehicles
Tracked vehicles
Vehicle description
CDT_FED_CPG
Tyre description
Goodyear 335/65R22.5 G275 MSA
General characteristics
Vehicle weight (kN)
66
Number of axles
2
Unladen tyre diameter (m)
1.01092
Unladen tyre width (m)
0.334
MMP according to Larminie's equations
Tyre deflection on hard surface (m)
0.05588
Factor K'
Get factor
1.83
Differential lock factor
0.97
MMP (kPa)
Calc MMP
312.5
MMP according to Rowland's equations
Unladen tyre section height (m)
0.21711
Tyre deflection on hard surface (m)
0.05588
Factor K'
Get factor
3.65
MMP (kPa)
Calc MMP
297.8
Vehicle Limiting Cone Index (VLCI)
Tyre deflection on hard surface (m)
0.05588
Factor K'
1.85
VLCI (kPa)
Calc VLCI
230.7
Enter the characteristics as indicated. Click on the buttons to perform the required tasks

# 5. VehSim2D

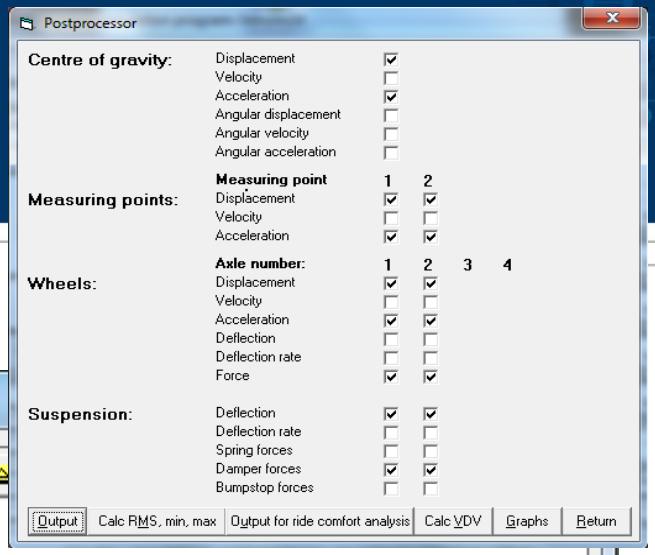

VehSim2d
Simulation program
VehSim2d v 2.3
for the simulation of vehicle dynamics
Registered to:
ARMSCOR
Program developed by:
Copyright
Serial nr: 708663075
OK

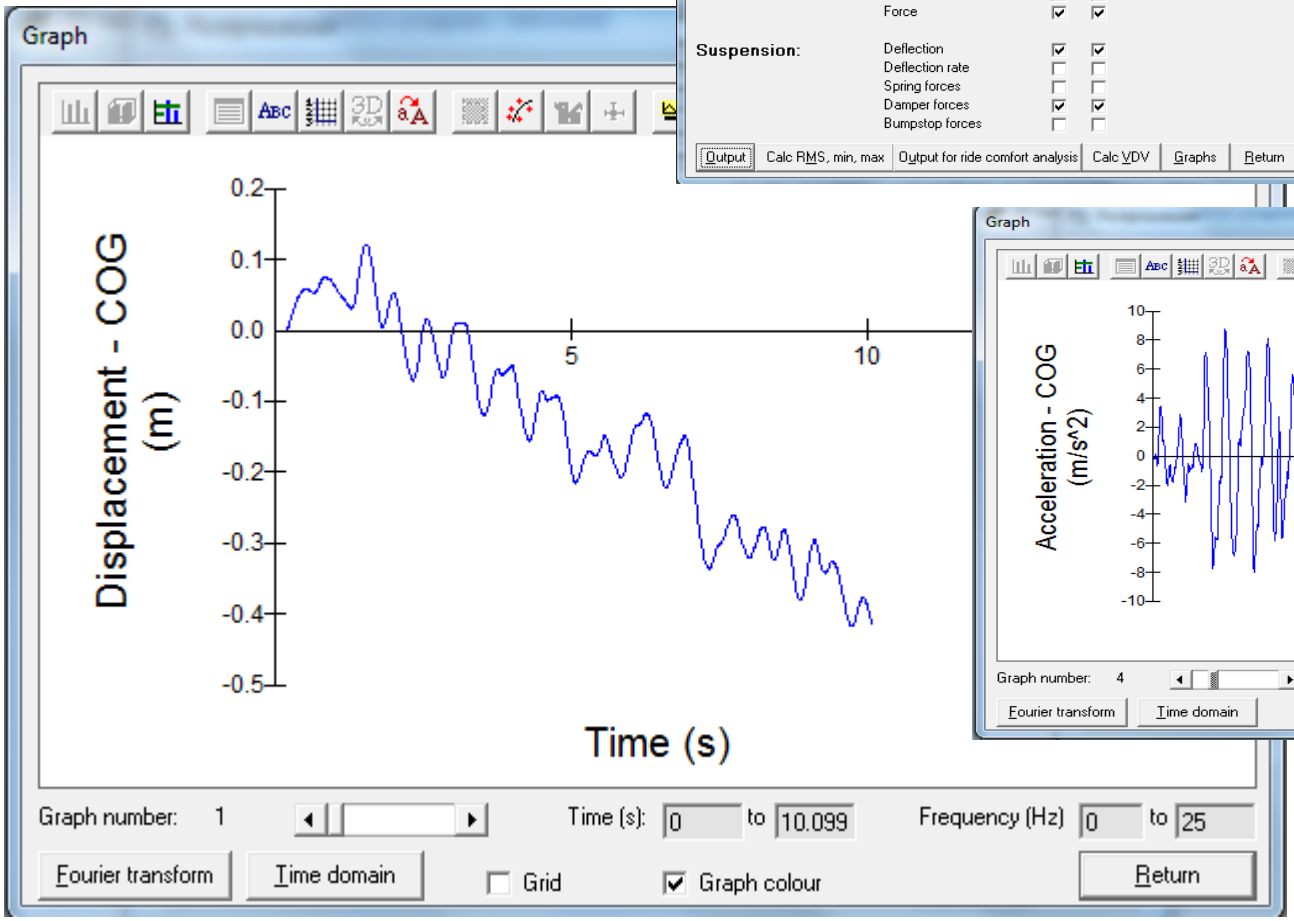

Two dimensional data editor
File
Damper description on axle 2
CDT_CPG_Koni_HF
Geometric damper ratio
0.5544
Number of dampers
2
Speed (m/s)
Damper Stiffness (Ns/m)
-0.33 25000
-0.1 57000
-0.03 32700
0.05 31800
0.125 18500
0.33 21000
Best linear fit on normal two dimensional data
CDT CPG Koni HF
Force (N)
Speed (m/s)
Right click on graph, for editing and printing
Update Data and graph
Return

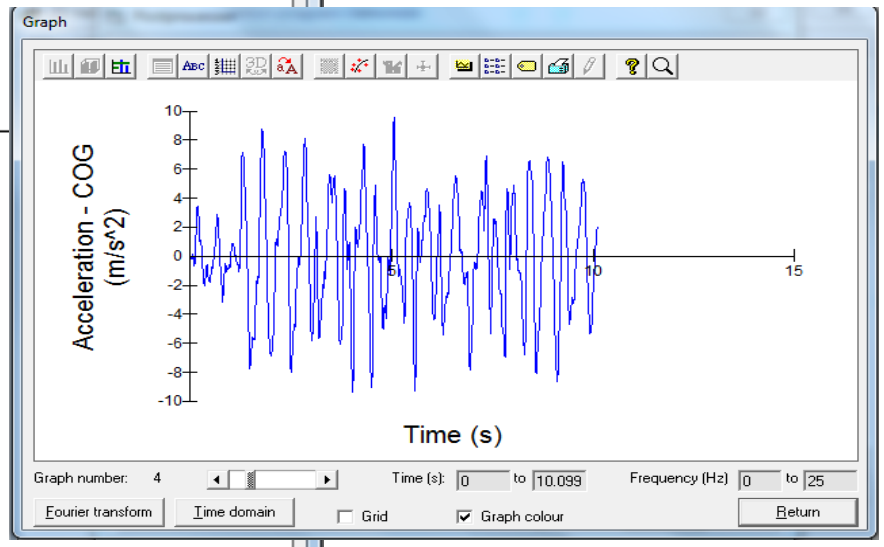

2D Vehicle dynamic simulation program: Vehsim2d
File
Help
Number of axles for vehicle:
2
Vehicle data
Vehicle description
CDT_CPG_Calib
MP - Measuring point
CG - Center of gravity
1.592 m
Sprung mass
2772.8 kgm2
MP2
0.422 m
0.362 m
MP1
4616.7 kg
-0.214 m
CG
-0.214 m
Vehicle speed
25.75
km/h
1.001 m
3.3 m
Route profile
434.87 kg
430.1 kg
Unsprung mass
Spring
Damper
Bumpstop
Tyre stiffness
Tyre damping
Geometry
Simulation data
Time step for simulation (s)
Time step for output to file (s)
End time (s)
Use sector tyre model
File names
Vehicle data
C:\...\CDT\CDT_FED_Calib_40p
Simulation output:
C:\...\CDT\CDT_FED_CPG_40p
Post processor input data
C:\...\CDT\CDT_FED_CPG_40p
Post processor output data
C:\...\CDT\CDT_FED_CPG_40p
Animation geometry
Edit
C:\MobSim\vehsim2d\data\CDT\CDT.ge
Run simulation
Postprocessor
Animate
LFOPC: Optimisation of vehicle/suspension parameters
Exit


Two dimensional data editor
File
Route profile description
RMS
Distance (m) Height (m)
-4 0
0 0
1 0
1.35 0.035
1.5 0.05
1.75 0.065
2.0006 0.0866
2.0768 0.0862
2.153 0.0856
2.2292 0.0805
2.3054 0.0824
2.3816 0.0809
2.4578 0.0757
2.534 0.0759
2.6102 0.0744
2.6864 0.0755
2.7626 0.0744
2.8388 0.0757
2.915 0.0769
2.9912 0.0776
RMS
Height (m)
Distance (m)
Right click on graph, for editing and printing
Update 2D Graph
Return

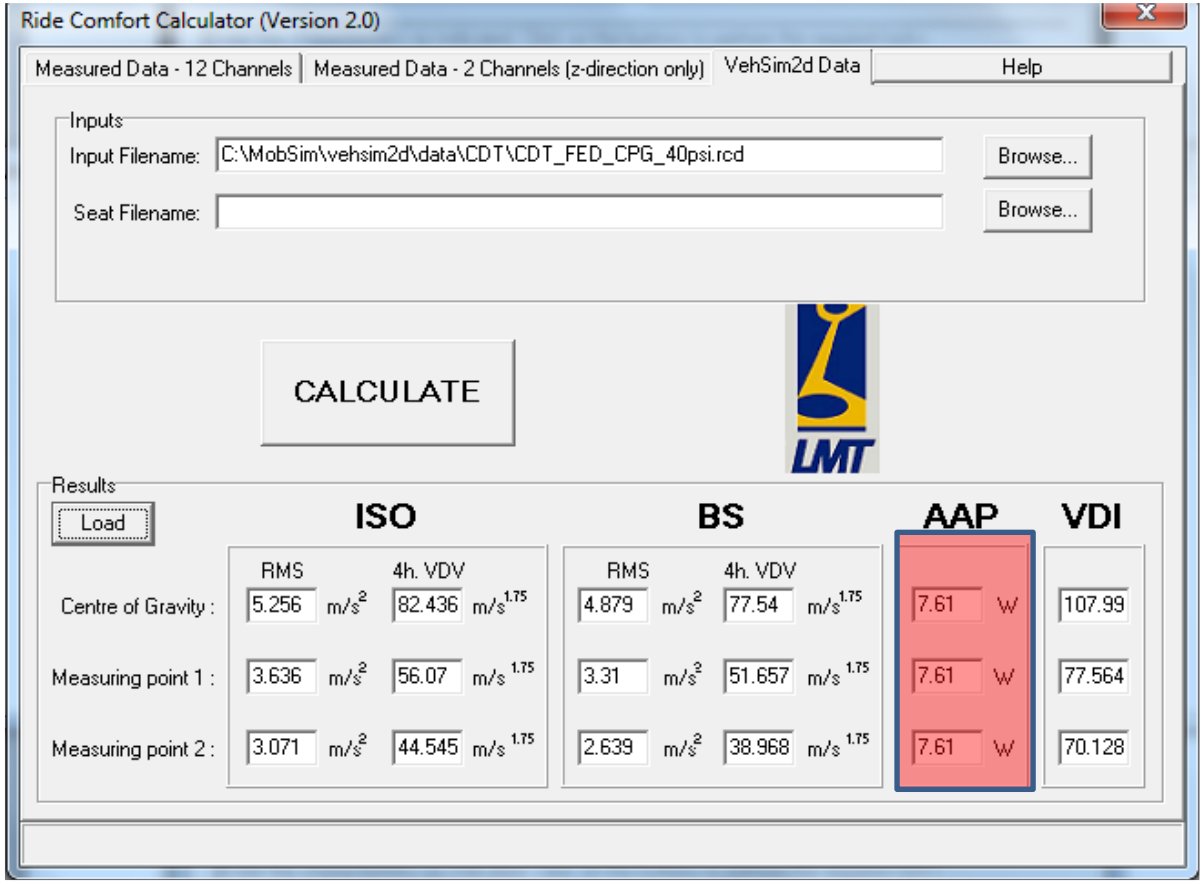
# 5. VehSim2D


Postprocessor
Centre of gravity:
Displacement
Velocity
Acceleration
Angular displacement
Angular velocity
Angular acceleration
Measuring points:
Measuring point 1 2
Displacement
Velocity
Acceleration
Wheels:
Axle number: 1 2 3 4
Displacement
Velocity
Acceleration
Deflection
Deflection rate
Force
Suspension:
Deflection
Deflection rate
Spring forces
Damper forces
Bumpstop forces
Output
Calc RMS, min, max
Output for ride comfort analysis
Calc VDV
Graphs
Return

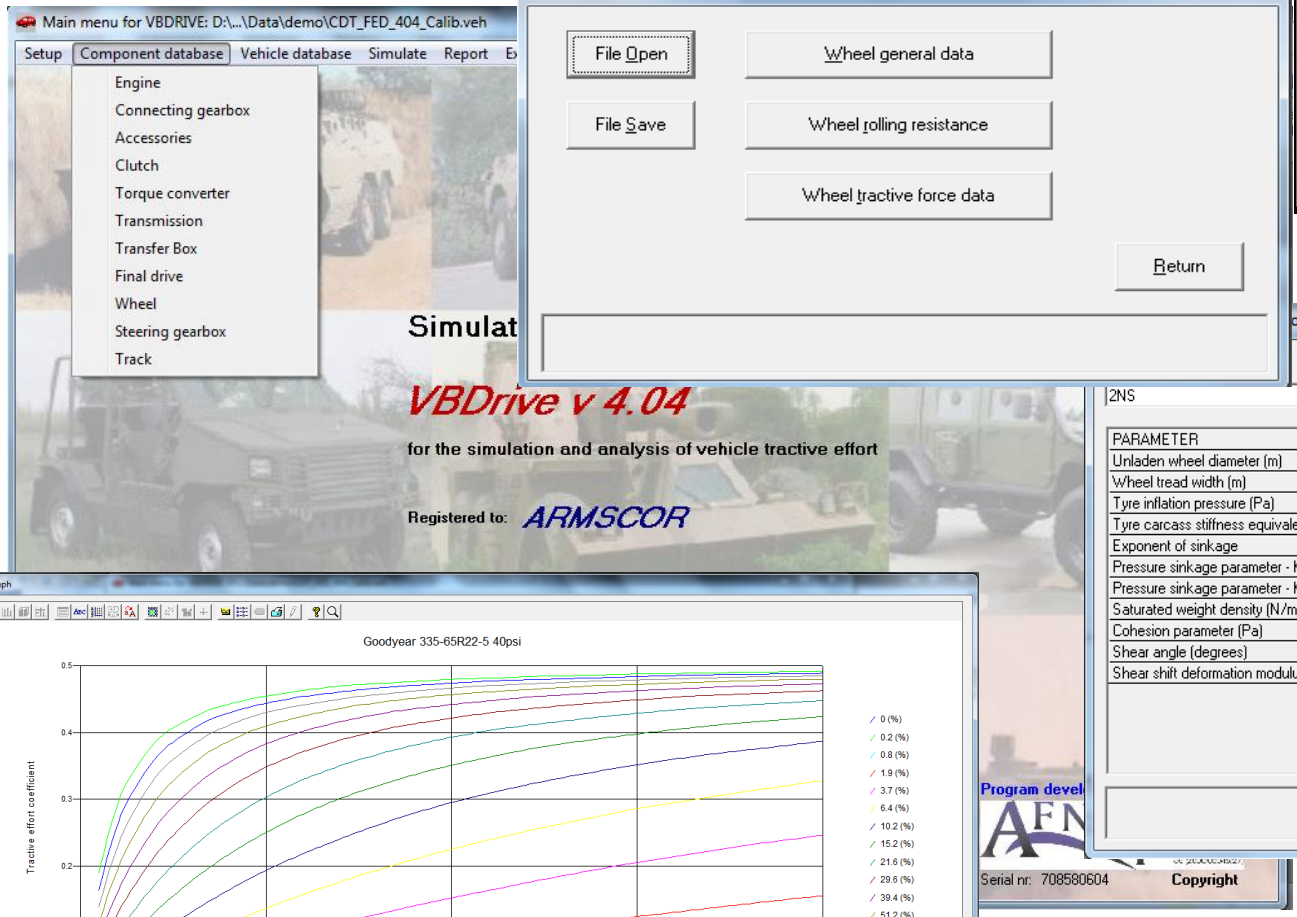

Graph
Displacement - COG (m)
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
-0.5
5
10
Time (s)
Graph number: 1
Time (s): 0 to 10.099
Frequency (Hz) 0 to 25
Fourier transform
Time domain
Grid
Graph colour
Return


Graph
Acceleration - COG (m/s^2)
10
8
6
4
2
0
-2
-4
-6
-8
-10
5
10
15
Time (s)
Graph number: 4
Time (s): 0 to 10.099
Frequency (Hz) 0 to 25
Fourier transform
Time domain
Grid
Graph colour
Return

# 6. RideCom

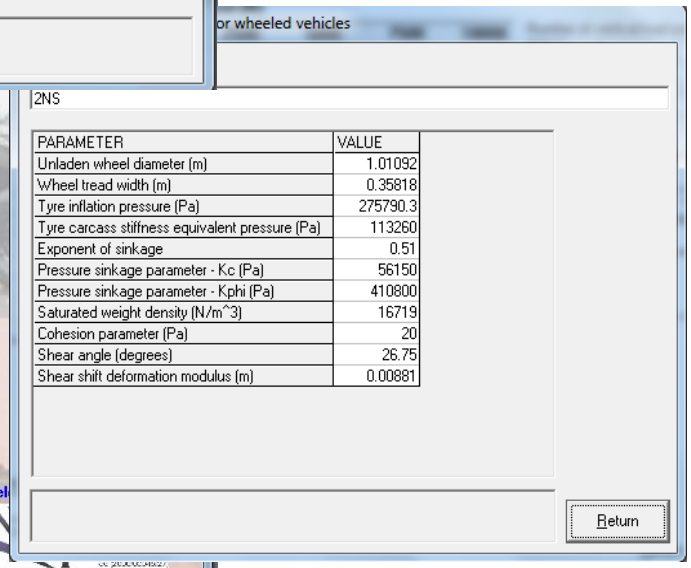

Ride Comfort Calculator (Version 2.0)
Measured Data - 12 Channels
Measured Data - 2 Channels (z-direction only)
VehSim2d Data
Help
Inputs
Input Filename:
C:\MobSim\vehsim2d\data\CDT\CDT_FED_CPG_40psi.rcd
Browse...
Seat Filename:
Browse...
CALCULATE
LMT
Results
Load
ISO
BS
AAP
VDI
RMS
4h. VDV
RMS
4h. VDV
Centre of Gravity :
5.256 m/s2 82.436 m/s1.75
4.879 m/s2 77.54 m/s1.75
7.61 W
107.99
Measuring point 1 :
3.636 m/s2 56.07 m/s1.75
3.31 m/s2 51.657 m/s1.75
7.61 W
77.564
Measuring point 2 :
3.071 m/s2 44.545 m/s1.75
2.639 m/s2 38.968 m/s1.75
7.61 W
70.128

# 7. VBDrive / VBDrive Electric



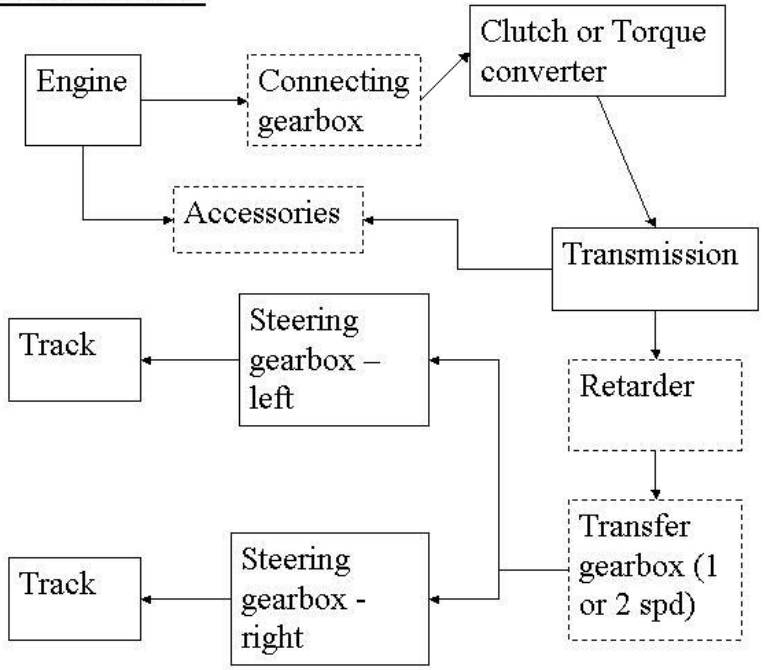




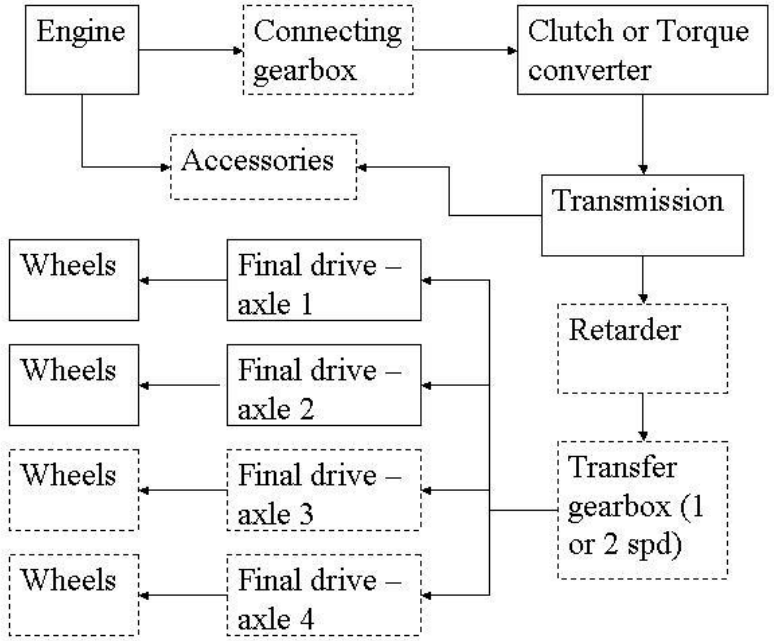



# 7. VBDrive / VBDrive Electric

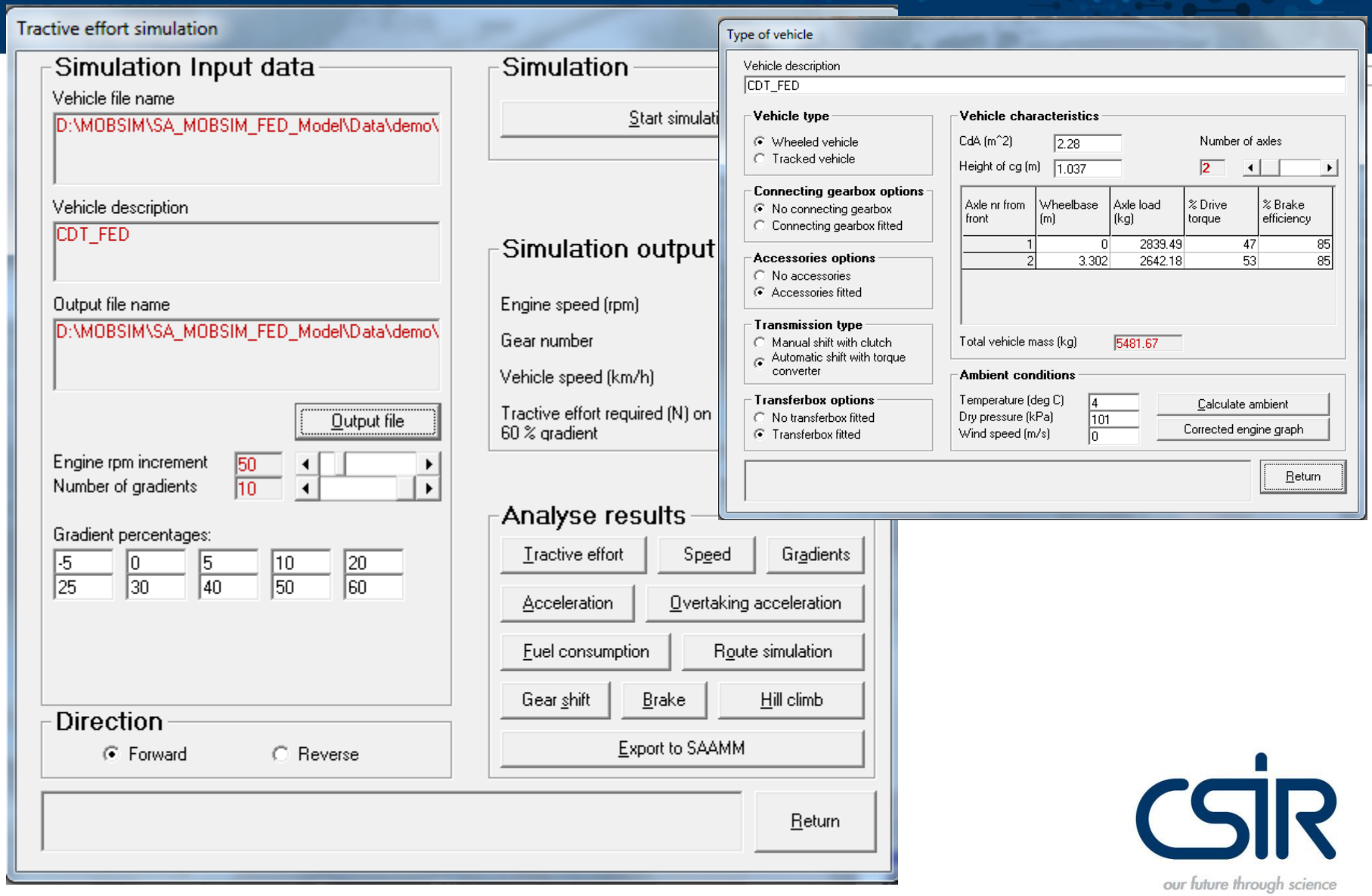
**Tracked vehicles**



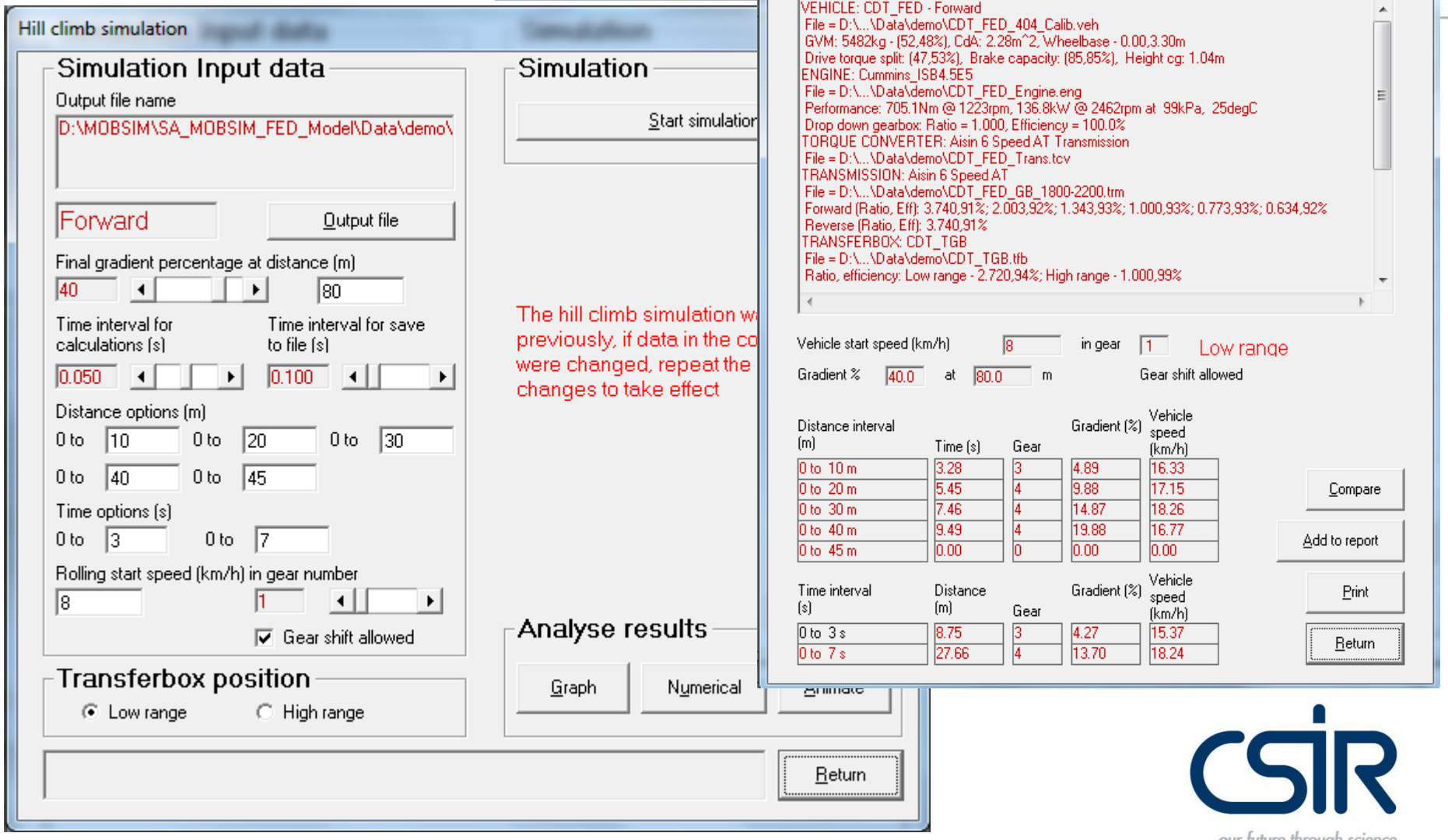

**Wheeled vehicles**



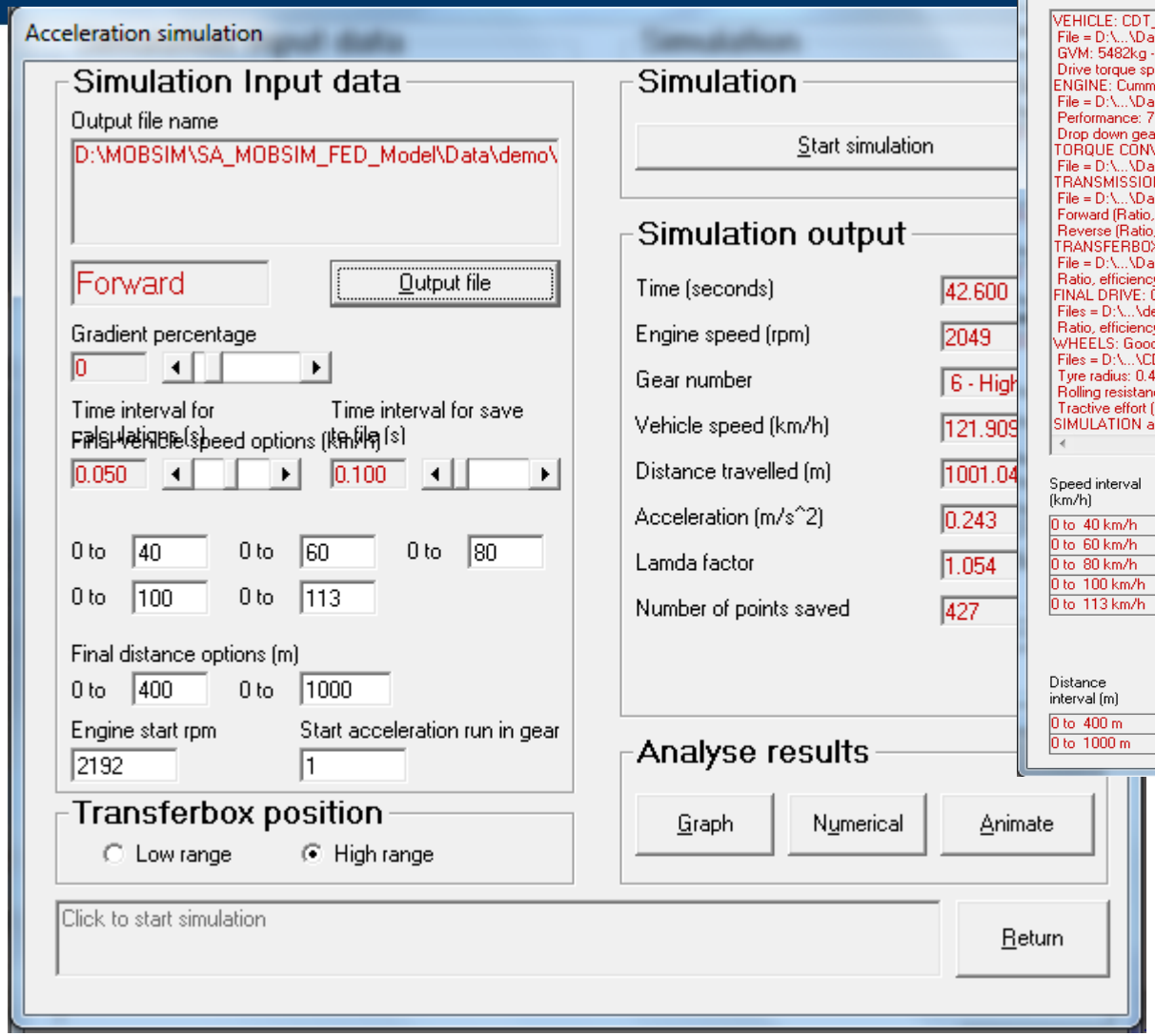
# 7. VBDrive / VBDrive Electric

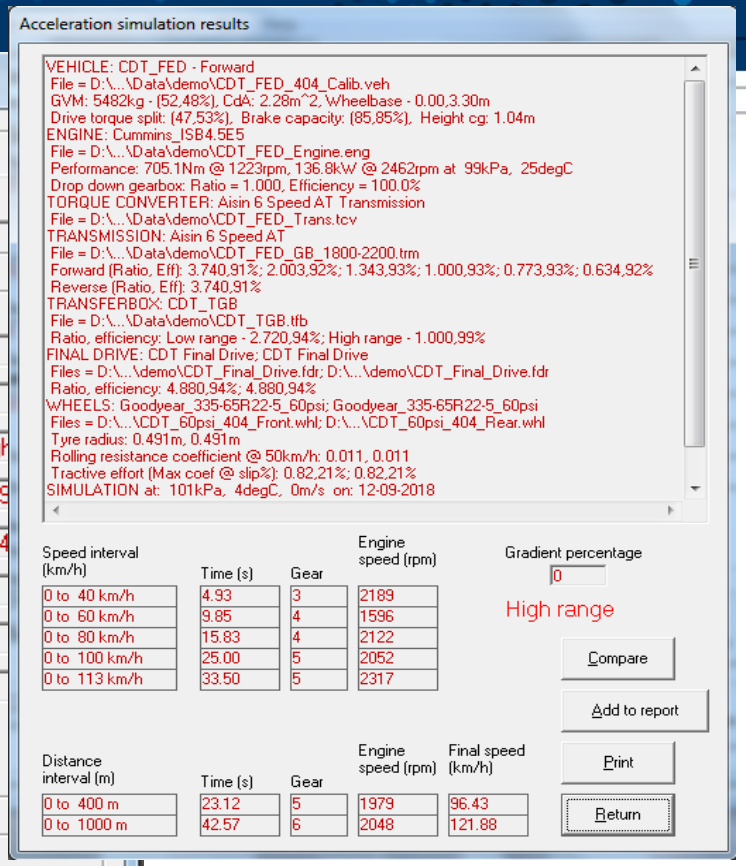


# 7. VBDrive / VBDrive Electric

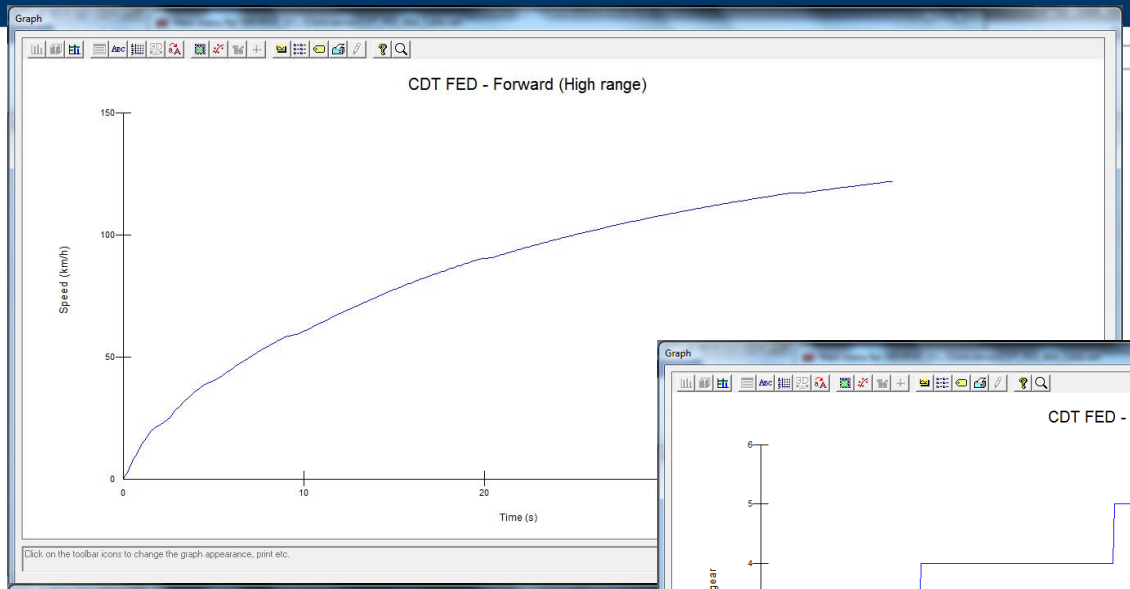


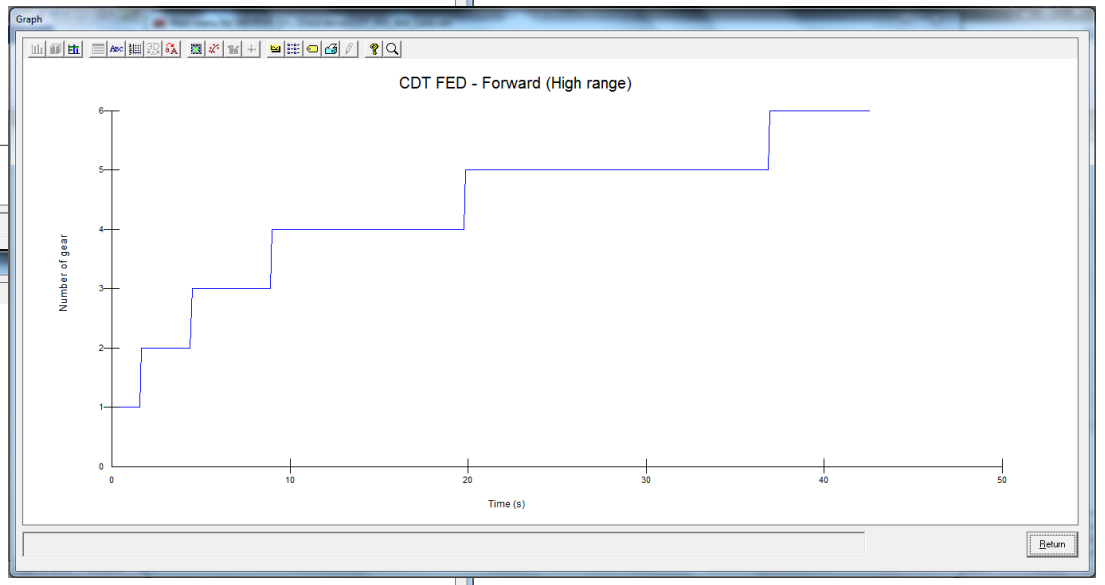
# 7. VBDrive / VBDrive Electric

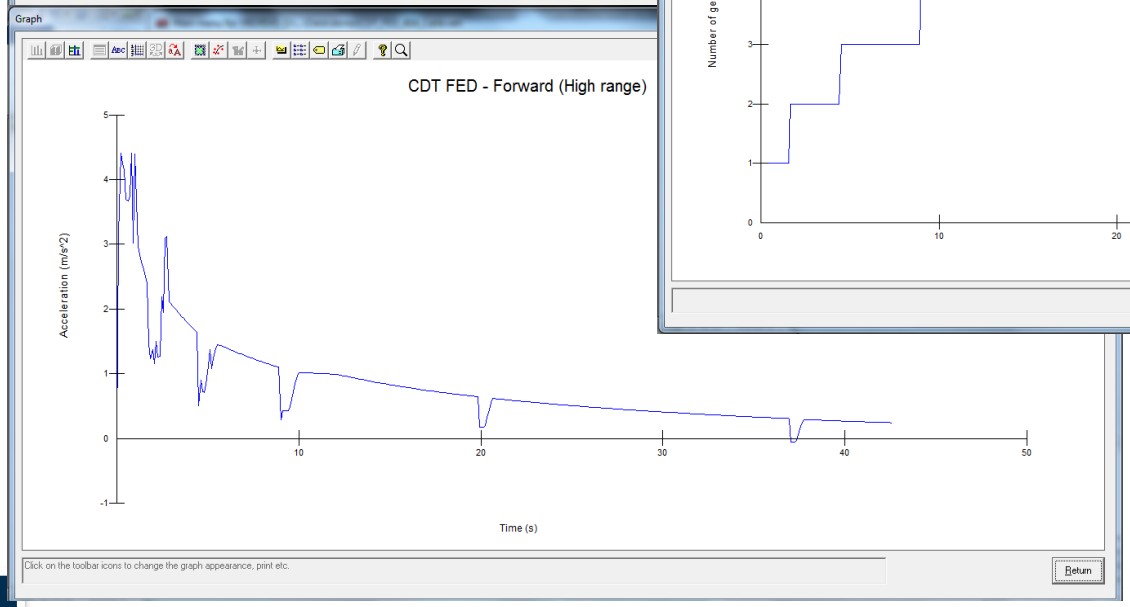


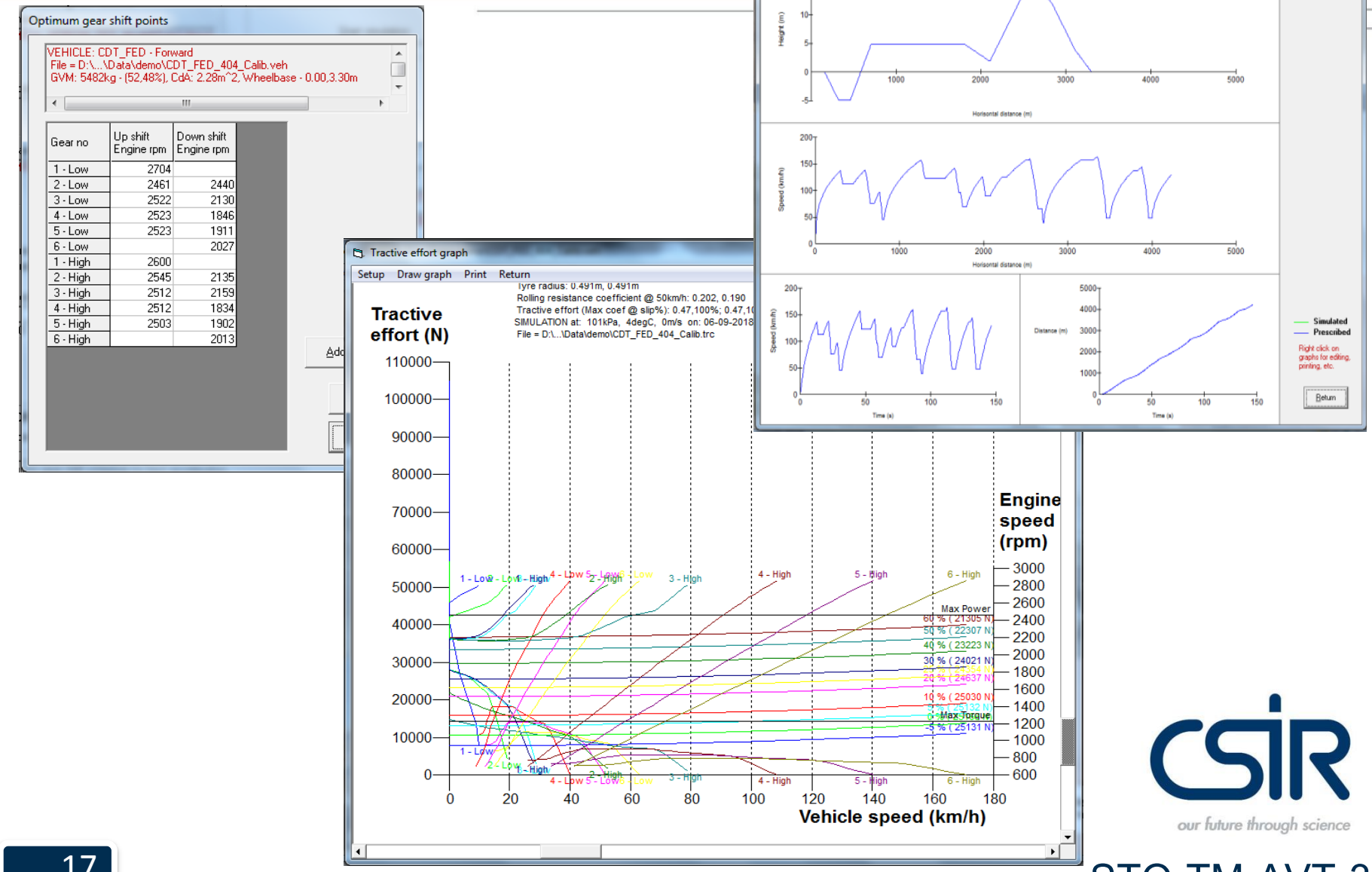
# 7. VBDrive / VBDrive Electric



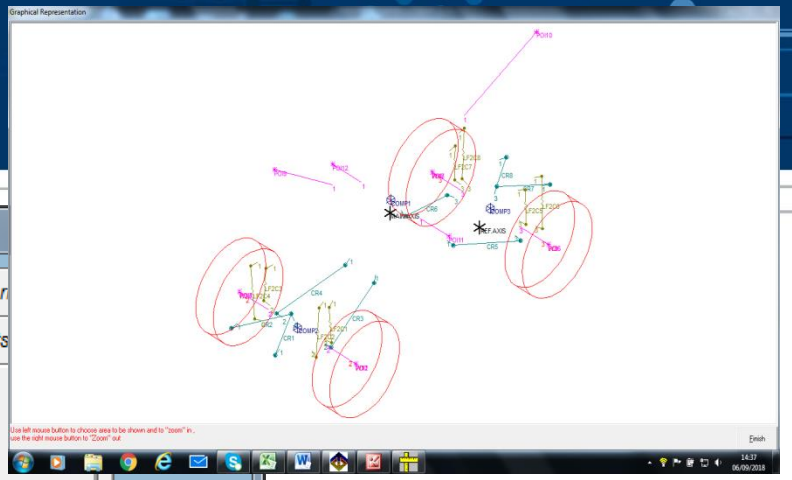



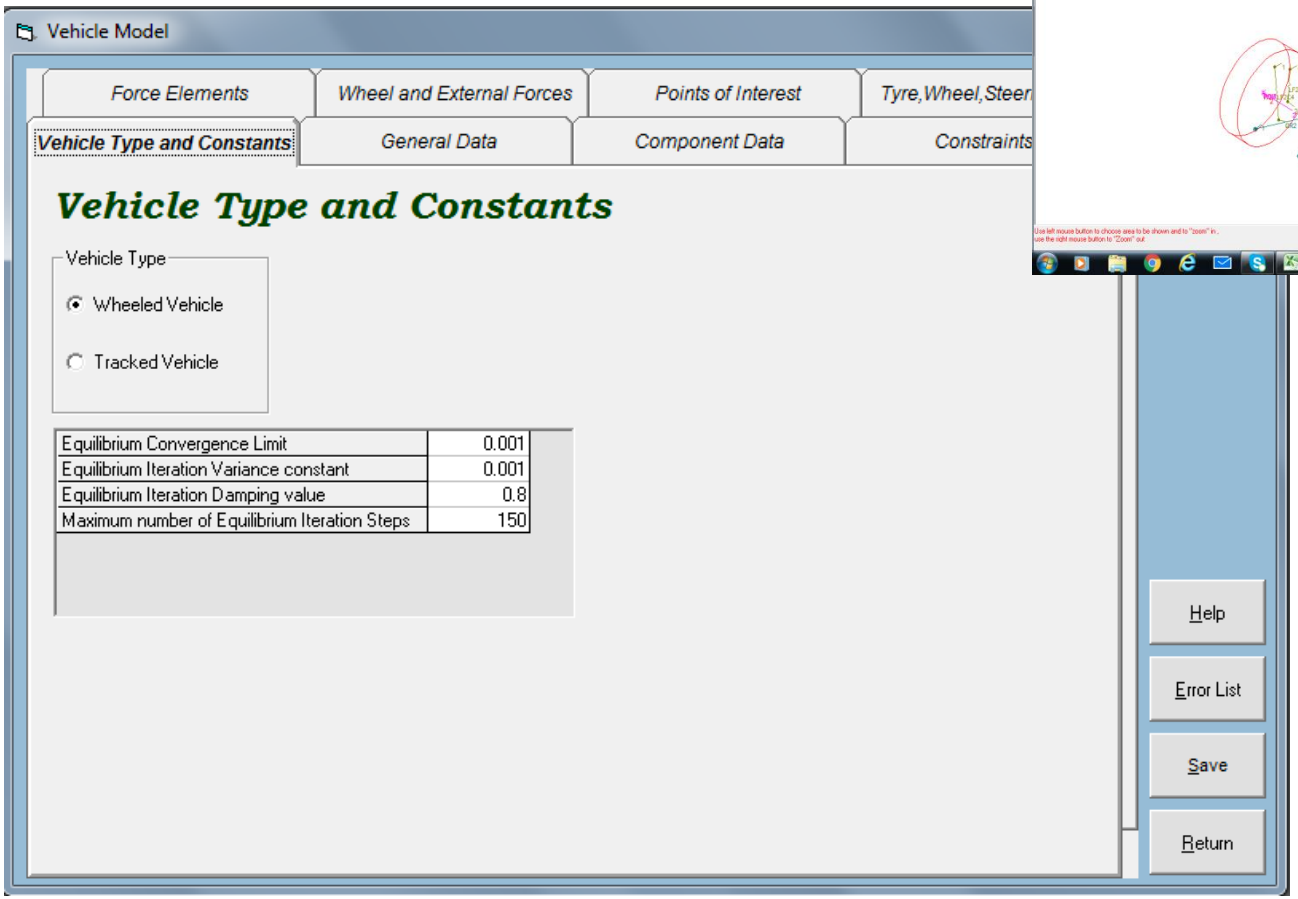



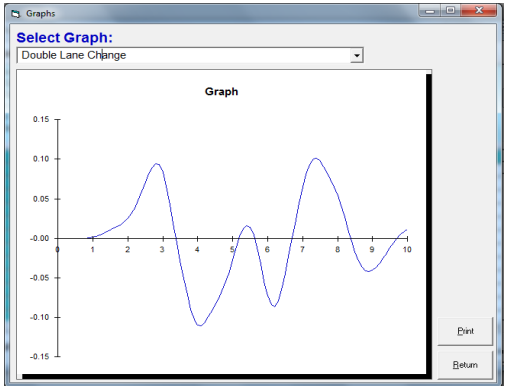
# 7. VBDrive / VBDrive Electric



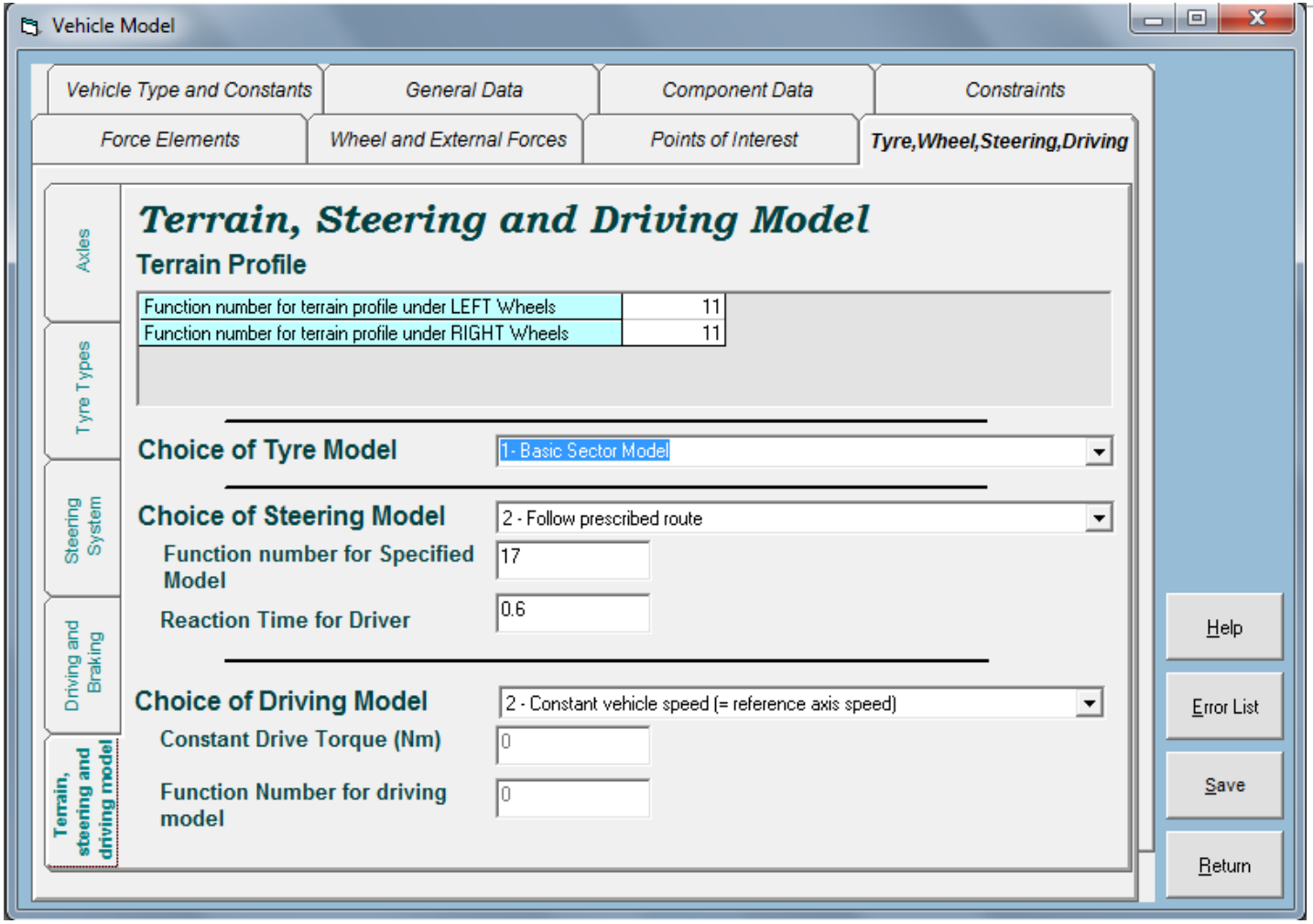
# 8. GENRIT



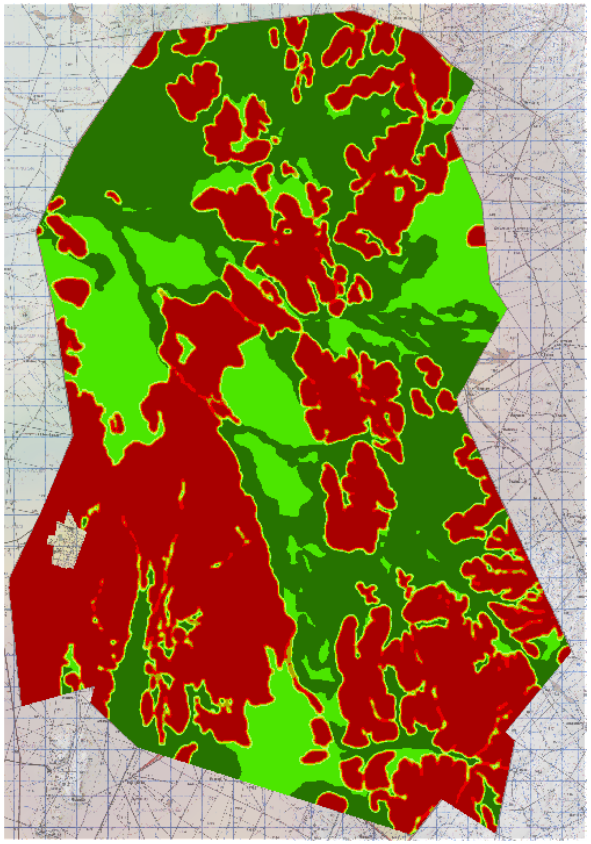

Vehicle Model
Force Elements
Wheel and External Forces
Points of Interest
Tyre,Wheel,Steer
Vehicle Type and Constants
General Data
Component Data
Constraints
Vehicle Type and Constants
Vehicle Type
Wheeled Vehicle
Tracked Vehicle
Equilibrium Convergence Limit 0.001
Equilibrium Iteration Variance constant 0.001
Equilibrium Iteration Damping value 0.8
Maximum number of Equilibrium Iteration Steps 150
Help
Error List
Save
Return

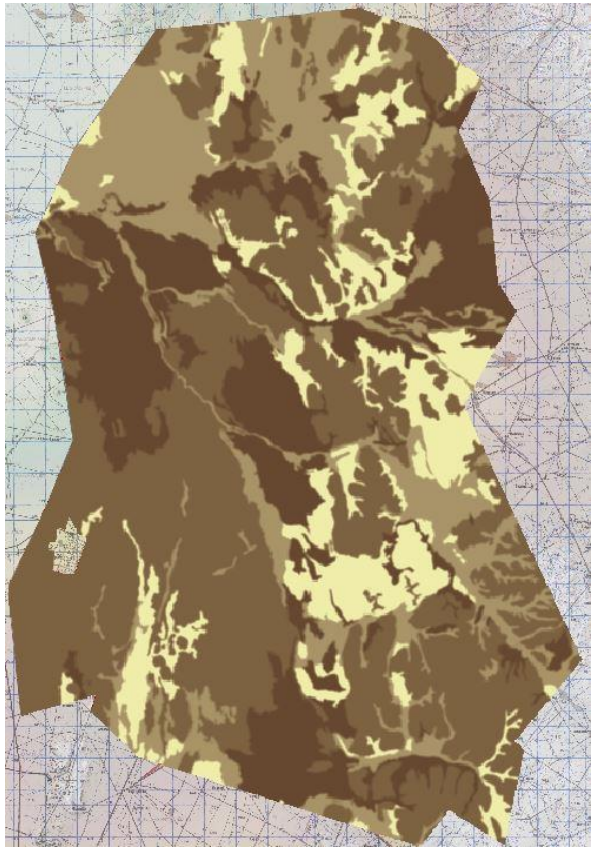

Graphs
Select Graph:
Double Lane Change
Graph
Print
Return

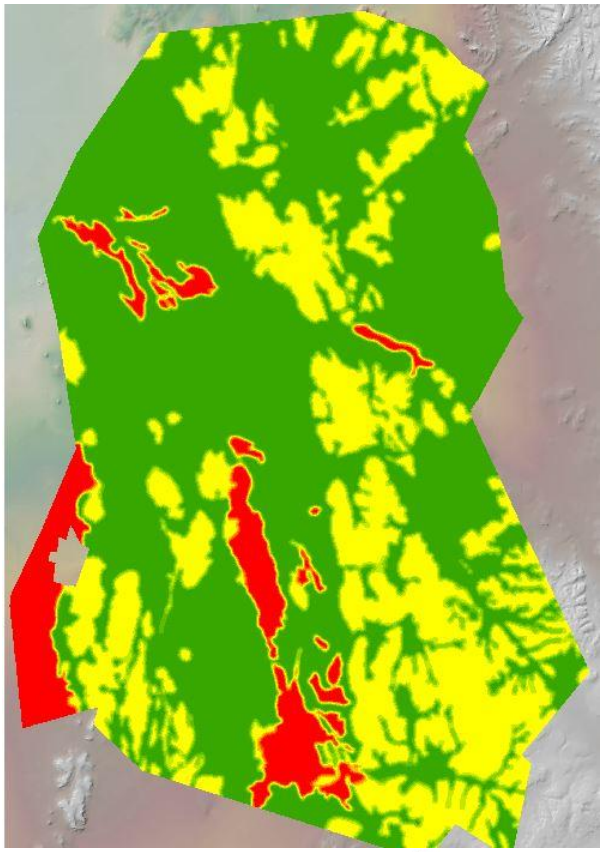
# 8. GENRIT


Vehicle Model
Vehicle Type and Constants
General Data
Component Data
Constraints
Force Elements
Wheel and External Forces
Points of Interest
Tyre,Wheel,Steering,Driving
Axles
Tyre Types
Steering System
Driving and Braking
Terrain, steering and driving model
Terrain, Steering and Driving Model
Terrain Profile
Function number for terrain profile under LEFT Wheels
11
Function number for terrain profile under RIGHT Wheels
11
Choice of Tyre Model
1- Basic Sector Model
Choice of Steering Model
2 - Follow prescribed route
Function number for Specified Model
17
Reaction Time for Driver
0.6
Choice of Driving Model
2 - Constant vehicle speed (= reference axis speed)
Constant Drive Torque (Nm)
0
Function Number for driving model
0
Help
Error List
Save
Return

# 9. SAAMM



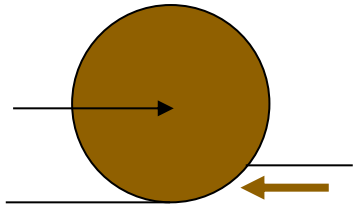


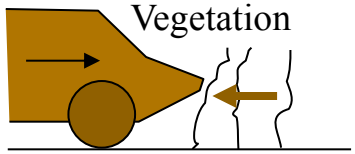


# 9. SAAMM

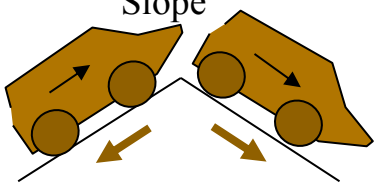
- SAAMM Speed Made Good / Maximum Possible Speed
  - Supply vs. Demand

Rolling






Slope



**Max Speed**

  - Speed constraints

Ride Comfort

Visibility: Vegetation

Visibility: Elevation

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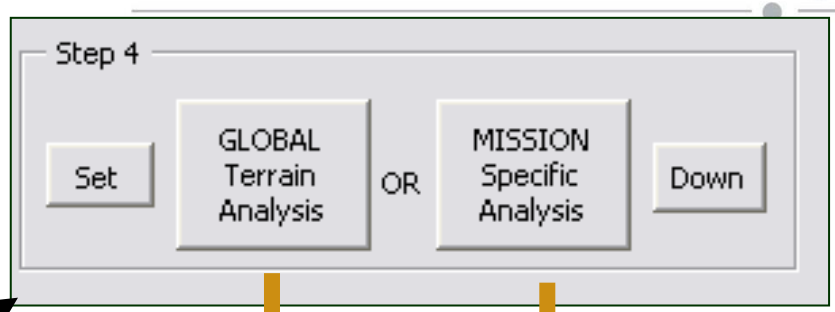
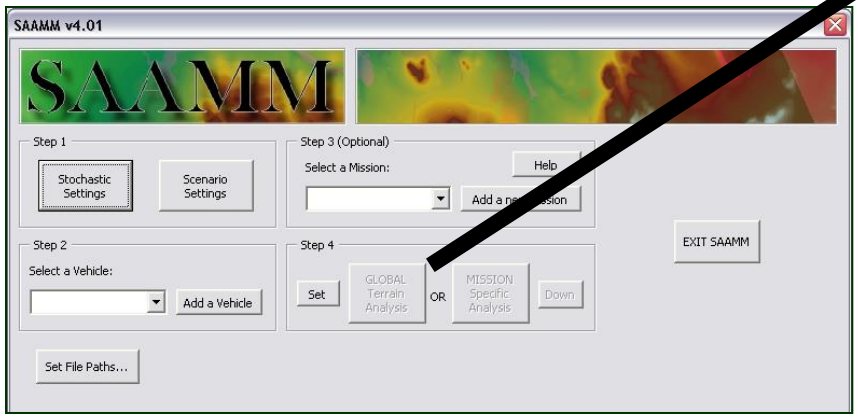
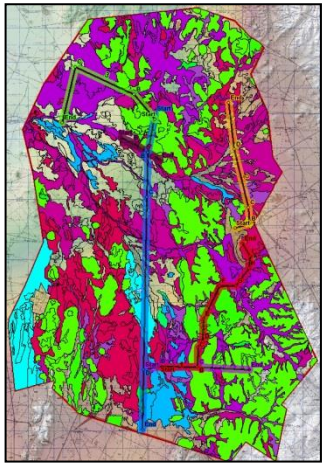
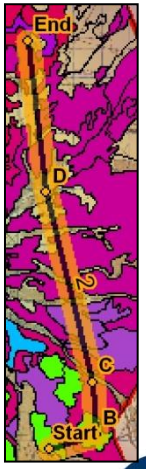
# 9. SAAMM

- SAAMM
  - ➢ Analysis options



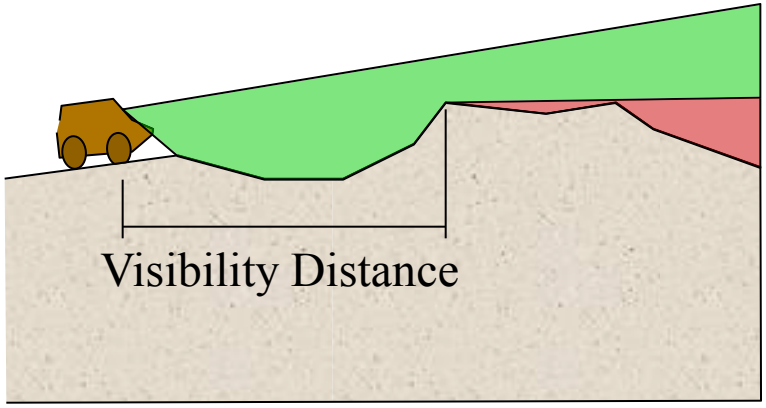



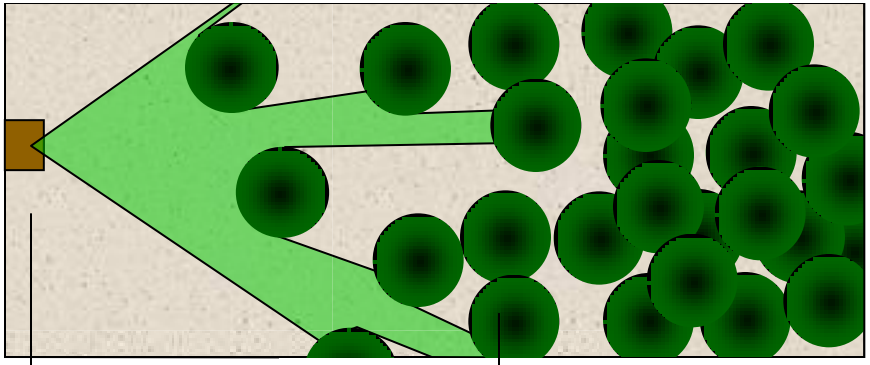



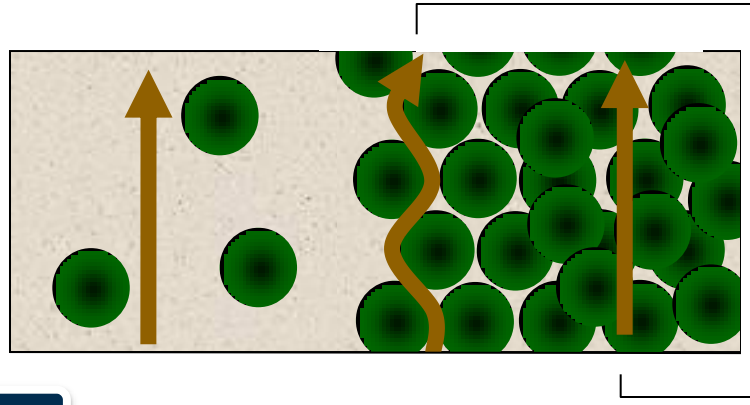


# 9. SAAMM

- SAAMM
  - Visibility modelling



# 10. MOBSIM Gaps

## Gaps

- Based on old software platforms (VBA / FORTRAN /ArcGIS9.0)
- Fixed outputs (Difficult to get other data e.g. rut depth nett tractive coefficient, Output data fixed format (jpeg plots v.s. CSV or similar data)
- Data input strings limited e.g. terrain roughness (smaller data strings)
- Excludes latest mobility modelling capabilities e.g. DEM
- Tedious to do multiple runs (manual inputs / model links)

## Advantages

- Low Cost (no software licences other than Windows)
- Fast (minutes to run on laptop)
- Well Structured GUI

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# Thank you

Name (email@csir.co.za)