

HERON Acceleration Program WGB

Brief overview

INTRODUCTION

In the early 1990 a car acceleration program was developed to investigate the influence of torque & power characteristics in combination with different gear ratios. Additionally, in the first release, also the fuel consumption was predicted.

Later, during the time at Mercedes-ILMOR, the WGB program was altered to the demands of F1 cars:

- Implementation of car velocity depending aero data (front and rear side)
- Dynamic tyre radius and surface friction coefficient ($f_{VELOCITY}$)
- Tyre slip values, wheel and engine inertia, shift speeds, centre of gravity, ...

The program was verified on so-called "straight-ahead acceleration events" where no braking or cornering was applied. The main purpose of the program was to analyse the potential of different power curve characteristics, shift strategies as well as gear ratio settings.

The program code is FORTRAN based.

The input data can be defined in a BASIC program or simple by editing the input data file.

The post-processing is done in a standard EXCEL xlsm sheet/program.

If requested, HERON can improve/modify/alter the program(s) for specific customer demands (e.g. US units).

This acceleration program can also be applied for simple automotive applications!

The following pages should give an overview about the program and its application.

For more information please contact

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INPUT DATA (Pre-Processing 1/3)

Pre-Processor for WGB - car accelerator simulation program

File | **General** | Engine | Gearbox | Tyre and Wings

Comments (max 80 characters per line).
 Test_Example_01
 July_2016

Comment line for Post Processor: Slope_Angle: +2Perc.

Ambient Pressure: 1.013 bar Ambient Temperature: 10 ° Celsius
 Calculation Time Step: 0.002 sec Wind velocity: -10 km/h (- ...head wind)
 Starting Gear No.: 2 Starting velocity: 80 km/h

Track data:
 Number of sectors: 2 (max. 5)

Sector	Distance m	Slope %
1	50	0
2	850	2

Calculated Distance: 850 m

Track Graph: Sector 2
 Y-axis: HEIGHT (m) from -100 to 100
 X-axis: Distance (m) from 0 to 850
 A red line shows a slight upward slope from 0 to approximately 10m at 850m distance.

Pre-Processor for WGB - car accelerator simulation program

File | **General** | **Engine** | Gearbox | Tyre and Wings

Power calculations
 No. of WOT-Torque points (max. 30): 30
(related to P_o = 1.013 bar at 25°C)

Speed rpm	Torque Nm	Power bhp
6000	198.9	167.6
6500	208.7	190.5
7000	218.4	214.7
7500	227.6	239.7
8000	232.7	261.4
8500	246.7	294.5
9000	258.1	326.2
9500	252.0	336.2
10000	255.1	358.2
10500	269.0	396.6
11000	285.8	441.5
11500	298.5	482.1
12000	301.4	507.9
12500	310.4	544.9
13000	321.3	586.6
13500	327.2	620.3
14000	341.2	670.8
14500	347.3	707.2
15000	349.0	735.1
15500	350.6	763.1
16000	351.8	790.4
16500	348.6	807.7
17000	343.0	818.8
17250	341.4	827.0
17500	338.3	831.4
17750	336.1	837.8
18000	333.0	841.7
18250	329.9	845.5
18360	327.2	843.6
18750	314.5	828.1

Engine Type (max 20 characters): ENGINE_FO110Q026x01

Displacement calculations:
 Bore: mm
 Stroke: mm
 Number of Cylinders: 10
 Total Displacement: 3.0 L

Torque Graph:
 Y-axis: TORQUE (Nm) from 0 to 400
 X-axis: SPEED (rpm) from 5000 to 19000
 Legend: Torque (red line), Power (blue line)
 The Torque curve peaks at approximately 350 Nm around 16000 rpm. The Power curve increases steadily, reaching about 840 bhp at 18000 rpm.

INPUT DATA (Pre-Processing 2/3)

Pre-Processor for WGB - car accelerator simulation program

File | General | Engine | **Gearbox** | Tyre and Wings

Gear data

Gearbox specification: MAL_P_2004_DC (max 20 characters)

Bevel: 16 23 1.44
Final: 14 56 4.00

Time for gear changes: 0.045 sec

No. of gears (max. 10): 7 | Downshift engine speed: 7200 rpm

Gear No.	Transmission ratio N1	N2	Slip %	Efficiency %	Shift rpm	Max. Velocity km/h
1	12	31	8	94	18100	162.0
2	14	31	5	94	18250	184.5
3	15	28	3	96	18350	215.6
4	18	29	2	96	18200	245.2
5	20	29	1	96	18250	270.4
6	19	25	1	96	18250	298.0
7	21	25	1	96	18250	329.4

Pre-Processor for WGB - car accelerator simulation program

File | General | Engine | Gearbox | **Tyre and Wings**

Tyre and Wing data

Speed km/h	R_{dyn} m	f_r	C_W	C_{DF}	C_{DR}
0	0.325	0.06	0.913	1.281	1.883
180	0.325	0.055	0.897	1.298	1.942
290	0.325	0.03	0.879	1.287	1.905
340	0.325	0.025	0.859	1.285	1.791

Inertia engine: 0.012 Nms²
Inertia tyres: 4 Nms²

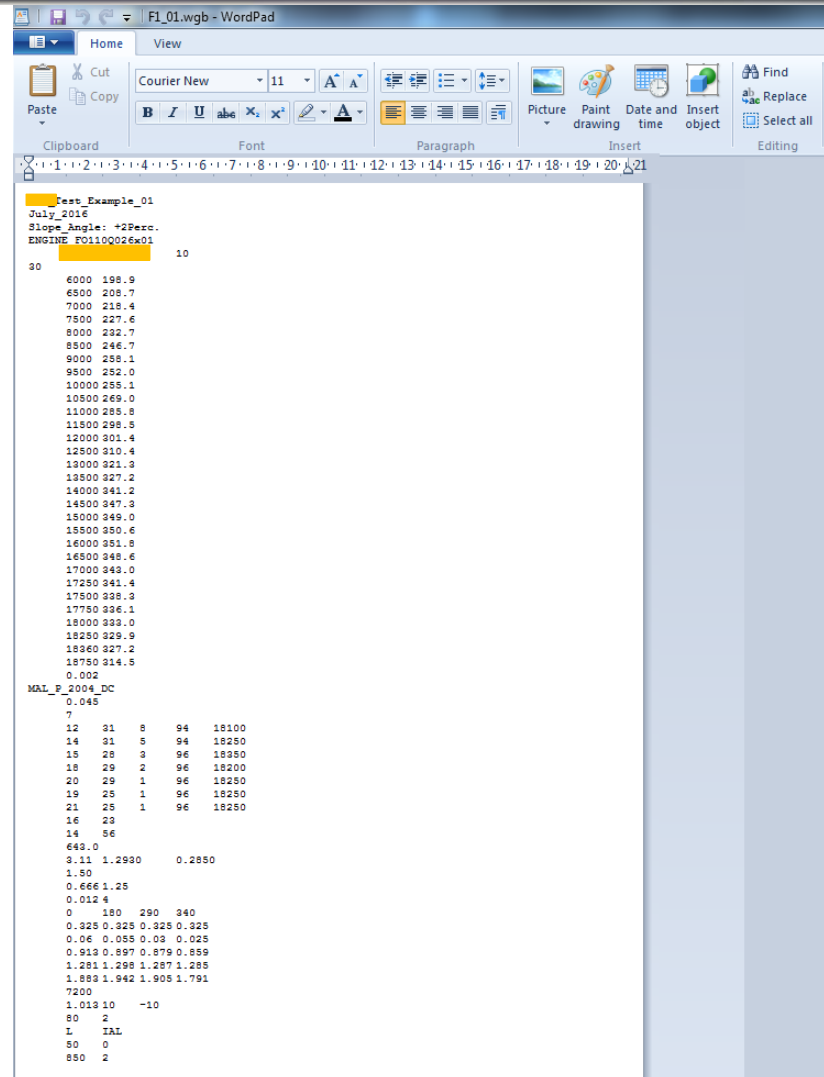
Front area, A: 1.50 m²
Wheel base, W_B : 3.11 m
Distance of C.o.G, a: 1.2930 m
Height of C.o.G, b: 0.2850 m
Track, c: 0.666 m
Friction coefficient: 1.25
Total mass (car + driver): 643.0 kg

Remarks

Downforce front: $F_{DF} = A \cdot \rho \cdot C_{DF} \cdot V^2 / 2$
Downforce rear: $F_{DR} = A \cdot \rho \cdot C_{DR} \cdot V^2 / 2$
Drag Force $F_W = A \cdot \rho \cdot C_W \cdot V^2 / 2$
Friction force $F_r = m \cdot g \cdot f$

INPUT DATA (Pre-Processing 3/3)

Data modification by simple file editing



The screenshot shows a WordPad window titled 'F1_01.wgb - WordPad'. The text content is as follows:

```
Test_Example_01
July_2016
Slope_Angle: +2Perc.
ENGINE_F01100026x01
30 10
6000 198.9
6500 208.7
7000 218.4
7500 227.6
8000 232.7
8500 246.7
9000 258.1
9500 282.0
10000 255.1
10500 269.0
11000 285.8
11500 298.5
12000 301.4
12500 310.4
13000 321.3
13500 327.2
14000 341.2
14500 347.3
15000 349.0
15500 350.6
16000 351.8
16500 348.6
17000 349.0
17250 341.4
17500 338.3
17750 336.1
18000 333.0
18250 329.9
18360 327.2
18750 314.5
0.002
MAL_P_2004_DC
0.045
7
12 31 8 94 18100
14 31 5 94 18250
15 28 3 96 18350
18 29 2 96 18200
20 29 1 96 18250
19 25 1 96 18250
21 25 1 96 18250
16 23
14 56
643.0
3.11 1.2930 0.2850
1.50
0.666 1.25
0.012 4
0 180 290 340
0.325 0.325 0.325 0.325
0.06 0.055 0.03 0.025
0.913 0.897 0.879 0.859
1.281 1.298 1.287 1.285
1.883 1.942 1.905 1.791
7200
1.013 10 -10
80 2
1 IAL
50 0
850 2
```

POST - Processing: Individual in EXCEL

WGB_post_F1.xlsm

Run W G B

	No.	Name		TIME [s]	Distance [m]	VELO [km/h]
Select 1	File 1	F1_01.ERG	Slope_Angle: +2Perc.	12.763	850	302.9
Select 2	File 2	F1_02.ERG	Slope_Angle: 0_Perc.	12.707	850	305.1
Select 3	File 3	F1_03.ERG	Slope_Angle: +2Perc.	12.653	850	307.3
Select 4	File 4					
Select 5	File 5					
Input File	INPUT F1_01.wgb July_2016 Slope_Angle: +2Perc. ENGINE_FO110Q026x01					

Starting directory: C:\HERON-Technik\WGB

Main Sheet to load and compare results file (*.erg)

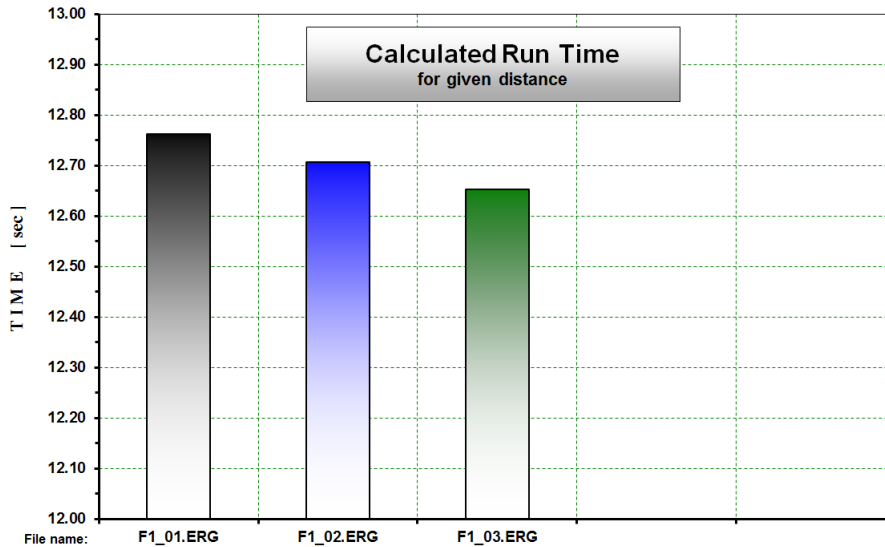
RESULTS

=====

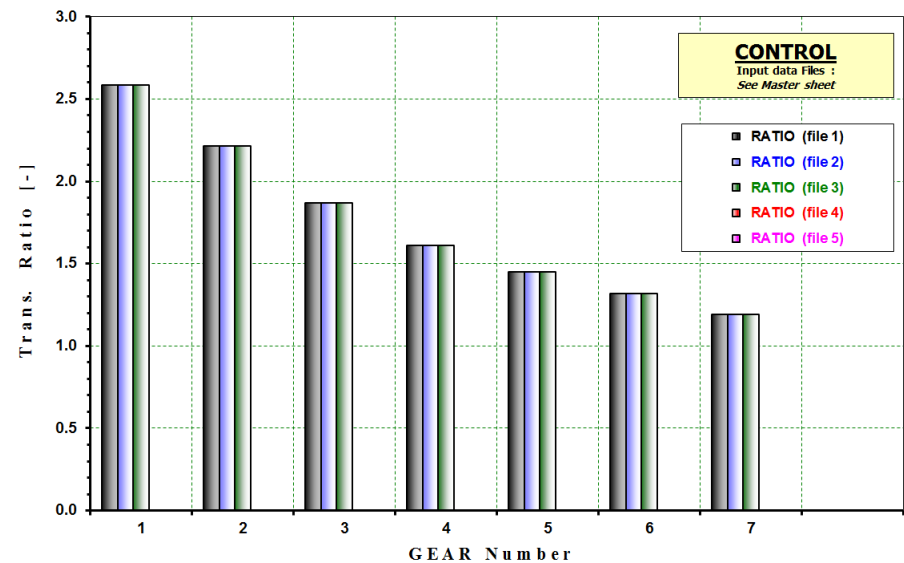
Nr	TIME	X	V	v	A	GEAR	SPEED	LOAD	Torque	FA	ROLL	WIND	STEIG	AV	AH	Power	ACC-E
[-]	[sec]	[m]	[m/s]	[km/h]	[m/s ²]	[-]	[rpm]	[%]	[Nm]	[N]	[N]	[N]	[N]	[N]	[N]	[PS]	[rpm/s]
1	0	0	22.22	80	8.49	2	8729.0	71	185.7	6362.4	486.8	418.5	0	2682.4	5110.0	230.9	
2	0.002	0.04	22.24	80.06	8.71	2	8735.9	74	193.7	6643.3	511.6	530.4	0	2818.9	5370.4	241.0	3420.9
3	0.004	0.09	22.26	80.13	8.72	2	8742.7	74	193.8	6647.5	511.8	531.2	0	2819.6	5372.4	241.4	3422.9
4	0.006	0.13	22.27	80.19	8.72	2	8749.6	74	194.0	6651.6	511.9	531.9	0	2820.3	5374.3	241.7	3424.8
5	0.008	0.18	22.29	80.25	8.73	2	8756.4	74	194.1	6655.8	512.1	532.7	0	2821.0	5376.3	242.0	3426.8
6	0.010	0.22	22.31	80.31	8.73	2	8763.3	74	194.2	6660.0	512.3	533.4	0	2821.7	5378.2	242.4	3428.7
7	0.012	0.27	22.33	80.38	8.74	2	8770.1	74	194.3	6664.1	512.4	534.1	0	2822.4	5380.2	242.7	3430.7
8	0.014	0.31	22.34	80.44	8.74	2	8777.0	74	194.4	6668.3	512.6	534.9	0	2823.1	5382.1	243.1	3433.1
9	0.016	0.36	22.36	80.50	8.75	2	8783.9	74	194.6	6672.5	512.8	535.6	0	2823.8	5384.1	243.4	3434.6
10	0.018	0.40	22.38	80.57	8.75	2	8790.8	74	194.7	6676.7	512.9	536.4	0	2824.5	5386.0	243.7	3437.0

List of output values in the results file (*.erg)

POST - Processing: Individual in EXCEL



Result Sheet: calculated time



Control Sheet: assumed gear ratios

