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ROAD VEHICLE SIMULATION USING AVL CRUISE

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Abstract: *Using simulation in electric vehicle design has several advantages as is an appropriate method for educational purposes, for teaching ensured the functioning of the components by following the shape of variation in time of currents and voltages, can give a vision accessible and documented the behavior of system performance, shortens the prototype development, allows the theoretical study of the destructive tests, can optimize performance objectives proposed by simulations on a large number of variables and does not generate costs.*

Keywords: AVL Cruise, vehicle simulation.

INTRODUCTION

Most systems from various branches of science (physics, chemistry, engineering, economics, sociology etc.) shows a high degree of complexity, it is described by a large number of variables and interactions. In many cases, attempts or direct measurements over phenomena in systems are cumbersome or even impossible. Causes the most diverse as: too dangerous, too expensive, too slow, too fast, too complicated or simply can not achieve the conditions of the study, the influence of the environment is too strong, there is no necessary means should be repeated many times or subject studied exist only in one copy (prototype).
In these situations, scientists use a technique to date on the implementation of virtual experiments: simulation. Simulation is an effective multidisciplinary field of investigation and give a scientific instrument character deeply and precisely, while offering the possibility of studying the real state of the systems without their physical composition.
Simulation technique is indispensable in the development of automobile and beyond. The need to simulate various electromechanical systems has emerged because of the need to reduce costs to design and manufacture prototypes and shorten the time interval from initial conception to realization of serial production.

PREPARING A VEHICLE MODEL SERIES WITH HYBRID RANGE EXTENDER

To simulate the operation of a hybrid vehicle with an extension of autonomy series was created and developed computer simulation model AVL Cruise in the application shown in Figure 1.
In the composition model includes the following elements:

1. Hybrid Electric Vehicle;
2. 4 cyinder ICE;
3. final drive;
4. vehicle rear left;
5. vehicle front left;
6. vehicle rear right;
7. vehicle front right;

8. rear disk brake;
9. front disk brake;
10. rear disk brake;
11. front disk brake;
12. eDrive;
13. Generator;
14. differential;
15. cockpit;
16. electrical system;
17. Li-ion Battery;
18. online monitor.

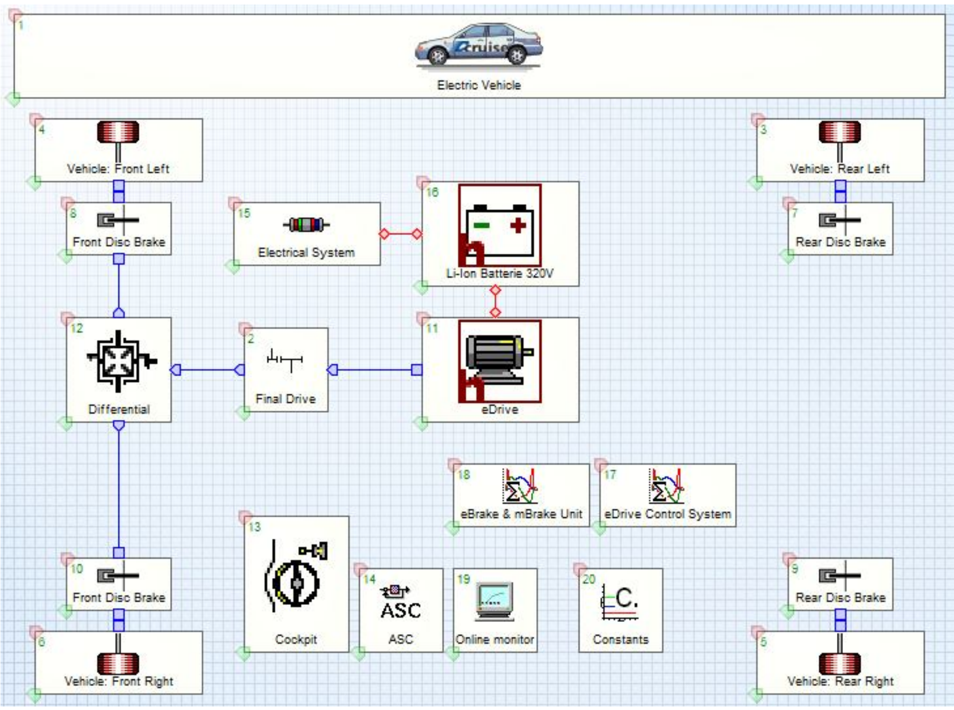

Figure 1. The general model of an electric vehicle with front-wheel and extension of autonomy (source AVL Cruise line 2011)

SIMULATION AND RESULT OBTAINED

Characteristics of the simulation model

If the battery is fully charged electric vehicle operates as vehicle type ZEV, propelled solely on the basis of energy taken from the traction battery.

The connections between the elements on the data bus Bus Connection Data are presented in Table 1.

Table 1. Connections between elements on the data bus Data Bus.

Component Requires	Input Information	Component Delivering	Output Information
ASC	Clutch release	Cockpit	Course ambient
	Load signal	Cockpit	Load signal
	Slip signal front left	Wheel front right	Slip signal
	Slip signal front right	Wheel front left	Slip signal
	Slip signal rear left	Wheel front right	Slip signal

Component Requires	Input Information	Component Delivering	Output Information
	Slip signal rear right	Wheel front left	Slip signal
Battery H	Ambient temperature	Cockpit	Course ambient
	Temperature external	Cockpit	Course ambient
Brake rear disk	Brake presure	E-Brake & M-Brake	BRK_dp_Recup
Brake front disk	Brake presure	E-Brake & M-Brake	BRK_dp_Recup
Brake rear disk	Brake presure	E-Brake & M-Brake	BRK_dp_Recup
Brake front disk	Brake presure	E-Brake & M-Brake	BRK_dp_Recup
Cockpit	Gear indicator	E-Machine	Operating mode
	Operation control 0	E-Machine	Operation control
E-Machine	Ambient temperature	Cockpit	Course ambient
	Load signal	E-Drive	Mod load signal
	Temperature external	Cockpit	Course ambient

Vehicle characteristics

To simulate this experimental model were used vehicle data extracted from the Dacia Logan, technical documentation presented in Table 3.2.

Table 2. Vehicle element characteristics

Element	Values	M.U.
Gas tank volume	5	[l]
Distance from hitch to front axle	4494	[mm]
Height of support point at bench test	100	[mm]
Wheel base	2634	[mm]
Height of Gravity Center empty / half / full	410 / 420 / 430	[mm]
Height of Hitch empty / half / full		[mm]
Tire Inflation Presure Front Axle	2.8	[bar]
Tire inflation Pressure Rear Axle	3.0	[bar]
Curb Weight	1016	[kg]
Gross Weight	1570	[kg]
Frontal Area	2.55	[m²]
Lift Coefficient Front/Rear Axle	0.032 / 0.010	[-]
Drag Coefficient	0.36	[-]

Electric car characteristics (electric motor)

E-Machine element (11) works in a motor to a generator components and braking. General data of the electric motor are shown in Table 3.
To calculate power losses defining characteristic maps for power Maximum Power (Torque) Mechanical Map (Figure 3.2) and yield efficency Map (Figure 2).

Table 3. E-Machine characteristics

Element	Values	M.U.
Type of Machine	ASM (Asynchronous Motors)	[-]
Nominal Voltage	205.0	[V]
Inertia Moment	1.0e-4	[kg·m²]
Maximum Speed	9000	[1/min]
Voltage U1 / U2	100.0 / 1000.0	[V]
Characteristic Maps and Curves	overall	[-]

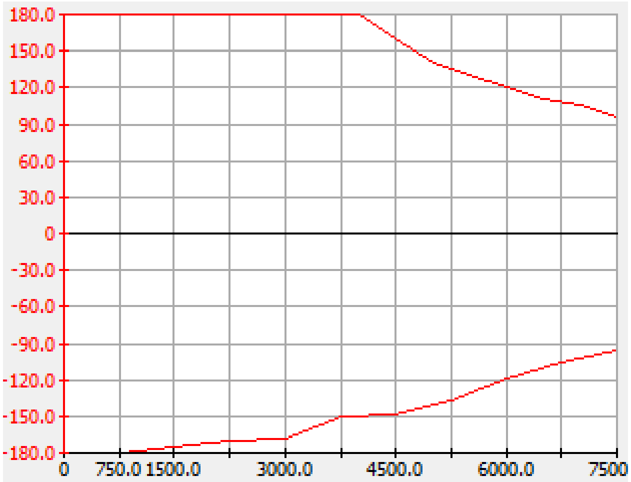

Figure 2. Torque characteristic in electric car accessories regime (top) and a generator (below)

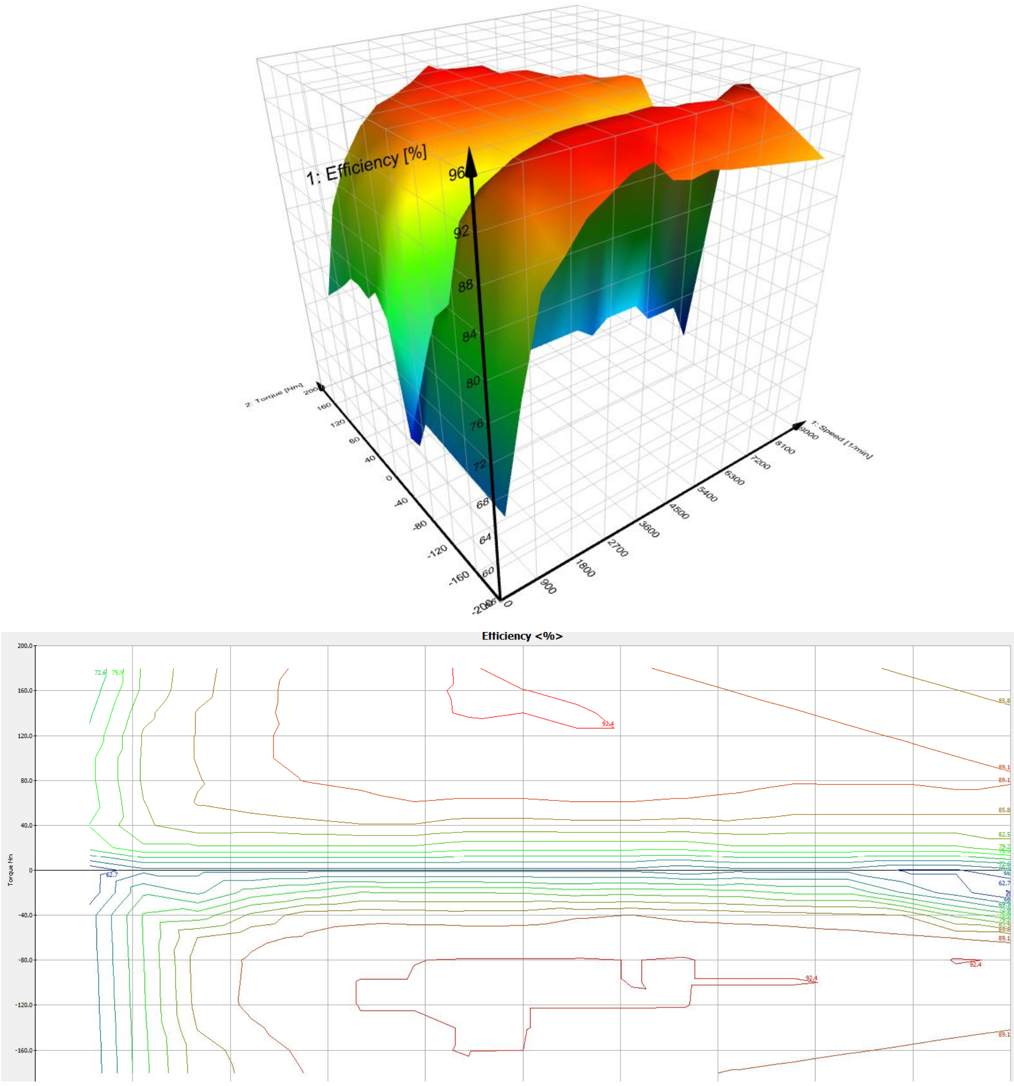

Figure 3. Efficiency of the electric car

Traction battery

Battery element (16) simulates the battery used to power electric vehicle. Electrical characteristics of the battery are shown in Table 4, and charging state SOC (State Of Charge) of the battery is shown in Figure 4.

Table 4. Battery H characteristics

Element	Values	M.U.
Maximum Charge	60	[Ah]
Nominal Voltage	205	[V]
Maximum Voltage	250	[V]
Initial Charge	95	[%]
Minimum Voltage	180	[V]
Number of Cell per Cell Row	8	[-]
Number of Cell Row	8	[-]
Internal Resistance Charge / Discharge	0.8 / 0.6	[Ω]

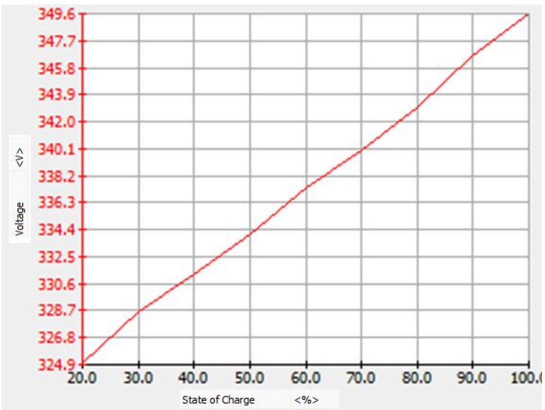

Figure 4. Battery SOC (State Of Charge)

SIMULATION RESULT

The simulation was performed in the New European Driving Cycle Driving cycle - Cruise v2014.Rezltatele NEDC using software obtained are expressed in graphical form and are displayed in the following way:

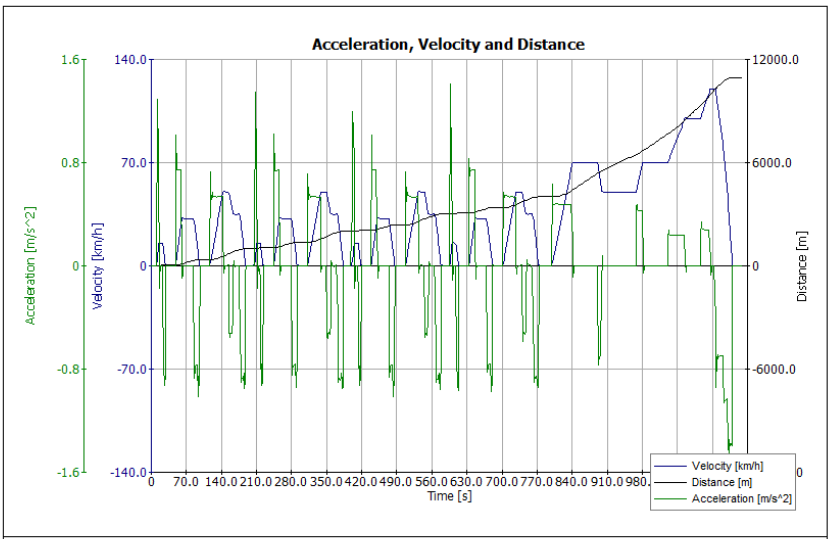

Figure 5. Variation of acceleration, velocity and distance versus time

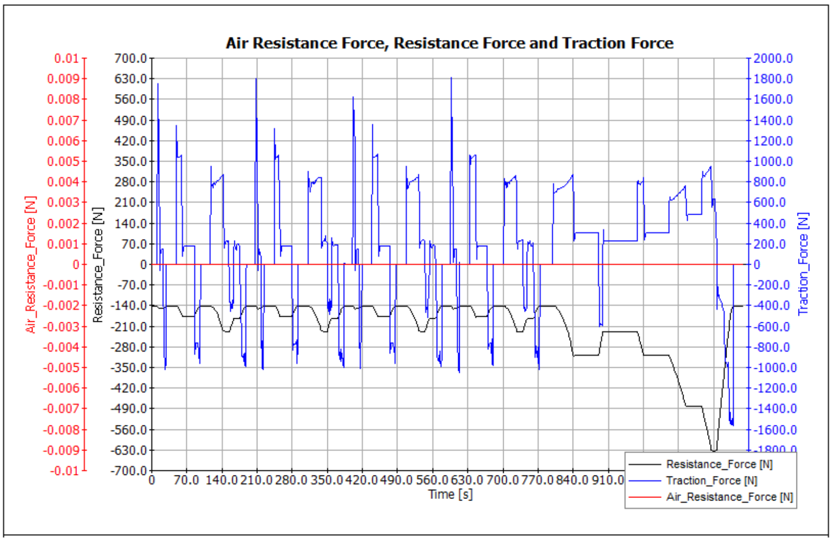

Figure 6. Variation air resistance, rolling resistance and traction in relation to time

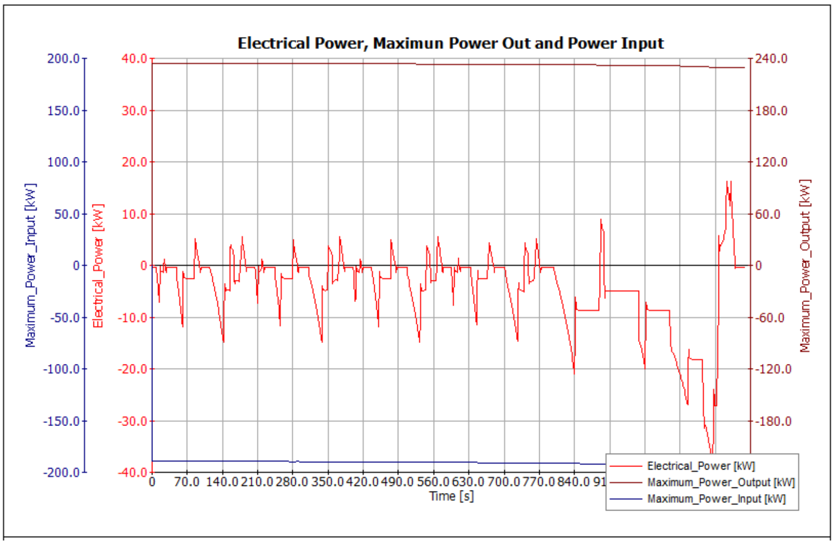

Figure 7. Electric power accumulated and consumed

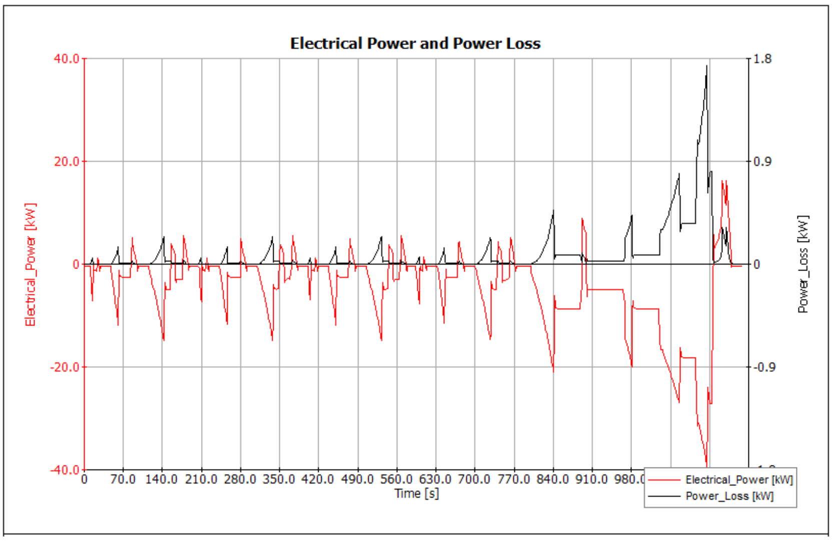

Figure 8. Electric power and power consumption

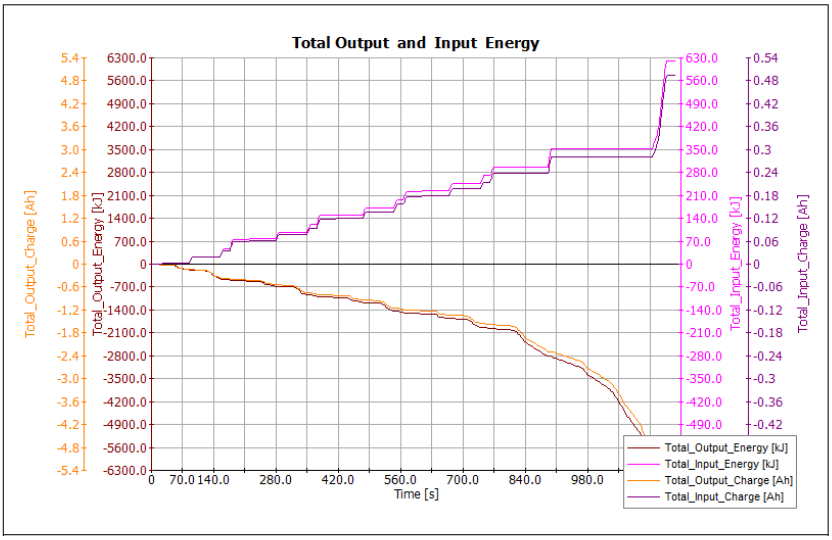

Figure 9. The total energy: input and output values

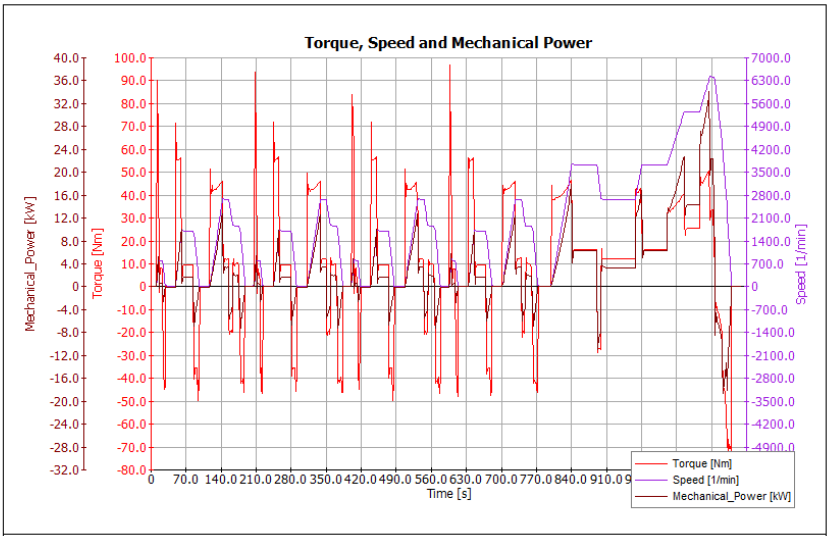

Figure 10. The timing, speed and mechanical power

CONCLUSIONS

Using simulation in electric vehicle design has several advantages such as:

- is an appropriate method for educational purposes, for teaching ensured the functioning of the components by following the shape of variation in time of currents and voltages;
- can give a vision accessible and documented the behavior of system performance;
- shortening the prototype development opportunities for learning because of problems specific system simulation;
- allows the theoretical study of the destructive tests, the response to faults and abnormal operating conditions;
- studying the effects of parasitic capacitance to a reactance such as flaws, the phenomenon of saturation etc.
- results of simulation waveforms can be easily monitored and analyzed replacing traditional measurement errors and disturbances subject;
- can be easily tested new concepts and circuit variations in circuit parameters (eg, component tolerances);

- can optimize performance objectives proposed by simulations on a large number of variables;
- does not generate costs.

Vehicle models developed app AVL Cruise, are made up of components that identifies items does with the actual elements from the point of view of the constructive and in terms of mathematical relationships that describe their operation. Thus, for each element constituting the model proposed in this study were defined mathematical relationships that help processes and characteristics calculation model during process development AVL Cruise simulation application.

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