



NIDEC ADVANCE TECHNOLOGY CORPORATION

xEV Modeling Simulator

Nidec Advanced Technology Corporation

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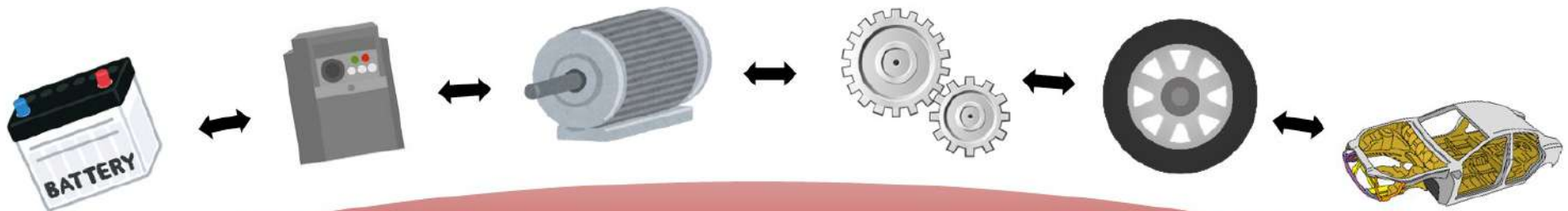
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Excellent Features of the xEV Modeling Simulator



Simultaneously performs combination calculations using AI* and detailed calculations based on theoretical formulas

*Uses AI called Generative Design, which shows multiple design possibilities based on constraints.



Simulates the entire electric vehicle with multiple outputs for optimal combinations

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Application of xEV Modeling Simulator

**Multiple output of
optimal combinations**



**Planning
(Initial **Assessment**)**

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**Simulation of the
entire electric vehicle**



**Digital Twin
(Detailed
Assessment)**

Planning (Component Planning Input Example)



Target1	<input type="text" value="120"/>	<input checked="" type="checkbox"/>	Number of Poles	<input type="range" value="6"/>
Target2	<input type="text" value="80"/>	<input type="checkbox"/>	Max. line current RMS peak power[A rms]	<input type="range" value="700"/>
Target3	<input type="text" value="1000"/>	<input checked="" type="checkbox"/>	Max. line current RMS continuous power[A rms]	<input type="range" value="300"/>
Target4	<input type="text" value="800"/>	<input checked="" type="checkbox"/>	Max. operational speed[rpm]	<input type="range" value="1.3e+04"/>
Target5	<input type="text" value="20"/>	<input type="checkbox"/>	Peak shaft torque @ Max. line current RMS peak power[Nm]	<input type="range" value="450"/>
	<input type="checkbox"/>			
	<input type="checkbox"/>			
	<input type="checkbox"/>			
<input type="button" value="Calculation"/>				

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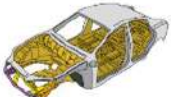



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<Procedure>

1. Display all parameters used in the WLTC simulation.
2. Check the checkboxes and specify values.
3. Use the slider bars to set the range of variables.
4. Click the button to start the calculation.

Planning (Component Planning Output Example)

SET1	SET2	SET3	SET4	
MOTOR-A 	MOTOR-B 	MOTOR-C 	MOTOR-D 	
INVERTER-A 	INVERTER-B 	INVERTER-C 	INVERTER-D 	
BATTERY-A 	BATTERY-B 	BATTERY-C 	BATTERY-D 	■ ■ ■ ■
Gear-A 	Gear-B 	Gear-C 	Gear-D 	
BODY-A 	BODY-B 	BODY-C 	BODY-D 	

<Output Results>
Candidates that meet the input parameter constraints are listed.

xEV Modeling Simulator's Digital Twin Feature

This simulator outputs the optimal solution by simulating the entire vehicle, including the characteristics of EV/HEV onboard drive motors and E-Axle. It helps in selecting motors that fit the vehicle conditions and driving **pattern**, shortens motor testing time, and improves the efficiency of analysing differences from actual measurements.

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Motor selection
Compatible E-Axle for the motor

Electric consumption (WLTC driving)
Distance travelled in one charge

Rotation speed-torque characteristics
Maximum torque and rotation speed

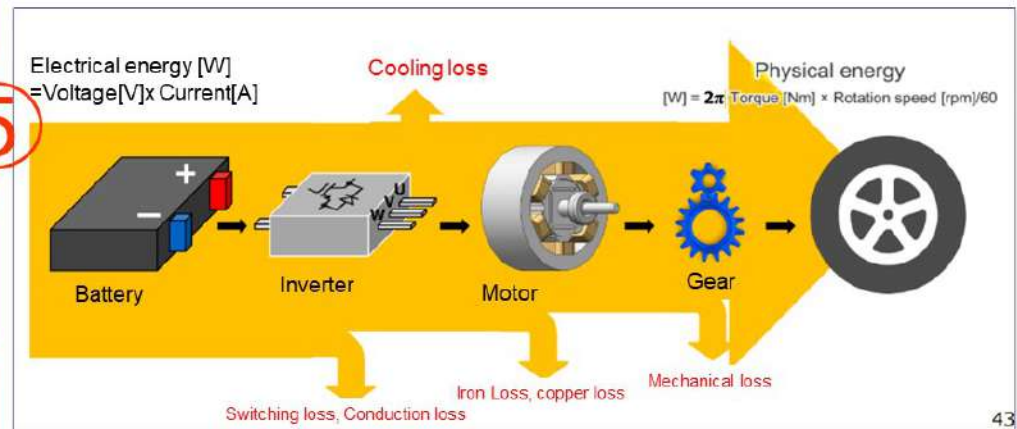
Output during WLTC driving
Inertia, gravity, speed, air resistance

Operating conditions
Vehicle speed and output power

Motor efficiency
Efficiency of automated driving

Loss and heat generation
Estimation of losses such as copper loss and iron loss

Efficiency characteristics
Efficiency during WLTC driving



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P-Loss Analyzer

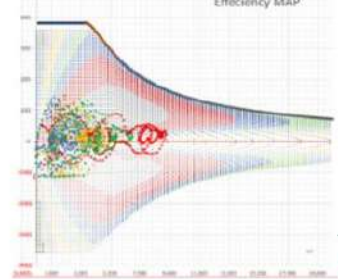
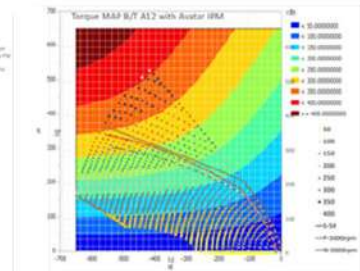
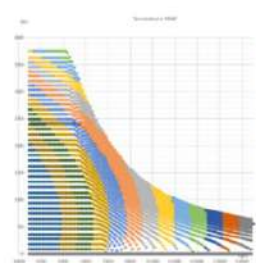
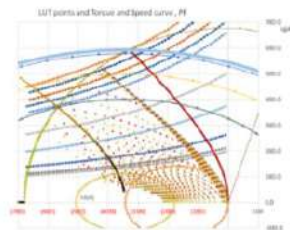
Torque and Speed Curve

Cruising Distance & BTT. by Sim & Pole

Temperature Map

Torque Map

WLTC : Motor Efficiency



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Improved User Interface

- Addition of components
- Customizable simulations
- Platform-independent (Web, Desktop, etc.)

xEV Modeling Simulator

Simulates the entire electric vehicle with multiple outputs to find the optimal combination.

Driving patterns (WLTC, CLTC, etc.)

Battery
characteristics
calculation

Inverter
characteristics
calculation

Motor
characteristics
calculation

Chassis characteristics calculation

Drive system
characteristics
calculation

Vehicle
system
characteristics
calculation

Gear system
characteristics
calculation

Drivetrain
characteristics
calculation

Expansion and Application Scope of Next-Generation Development Targets

Motor



Currently: IPMSM



Future: New Motors/Twin Motors

Application



Currently: Electric cars



Future: All Electric Vehicles

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Expansion of collaboration in the development environment

Collaboration expansion in the development environment

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Integration with Motor Bench, Reference Inverter, and EV Simulator

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NIDEC - Construction of an Optimized Development System

BtoB Test Bench + **xEV Modeling Simulator** + **SiC Reference Inverter**

Evaluation (B to B Test Bench)



Measured data

AI Automatic Completion of
Measurement Data by Simulator

Providing a next-generation **development environment** not available from other companies

Design (xEV Modeling Simulator)

モーター理論式
磁気設計ノウハウ

$$\psi_{0a} = \psi_{0a} + i_{0a} \cdot \psi_{0b} = i_{0b} \cdot \psi_{0a}$$

$$\psi_{0a}^2 = \psi_{0a}^2 + \psi_{0b}^2$$

$$\psi = f(\psi_0) = \psi_{max} \tanh\left(\frac{\psi}{\psi_{max}}\right)$$

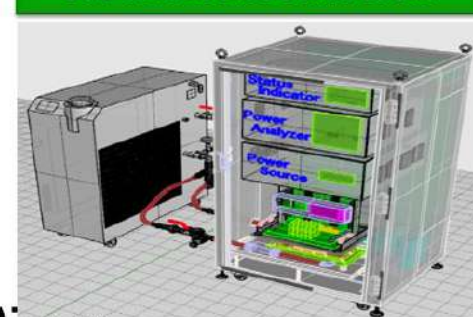
$$\psi_a = \psi_{0a} \cdot \psi, \quad \psi_b = \psi_{0b} \cdot \psi$$

Extraction of Optimal Parameters

Production (Manufacturing Plant)



SiC Reference Inverter



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