A Case Example of JMAG-RT Application in an Electrical Automotive MBD

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Abstract :
In analysis of a motor drive system's performance, the mainstream method narrows things down to a general, ideal condition (a mathematical sine wave drive) that is easy to calculate and argues the pros and cons of a main representative, such as the limit performance of a motor, which is nothing more than a single part of the entire system. In JMAG-Studio alone it is not possible to recreate exactly the operating range and interactions of changes in efficiency when the motor is connected to the surrounding system, so at Mashida, where we were aiming at "a limit design for a dynamic system," we constructed a rapid calculation environment using JMAG-RT that would give us a good overall view of the interactions and trade-off functions of the system interior.

Development of the
Mazda Dual Mode Drive System

- Application of JMAG-RT on Electric Propulsion Automotive Vehicles MBD Process -

Technical Research Center
- Takashi Yonemori, Naoki Itasaka

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Purpose

What do we wish to do, and why?

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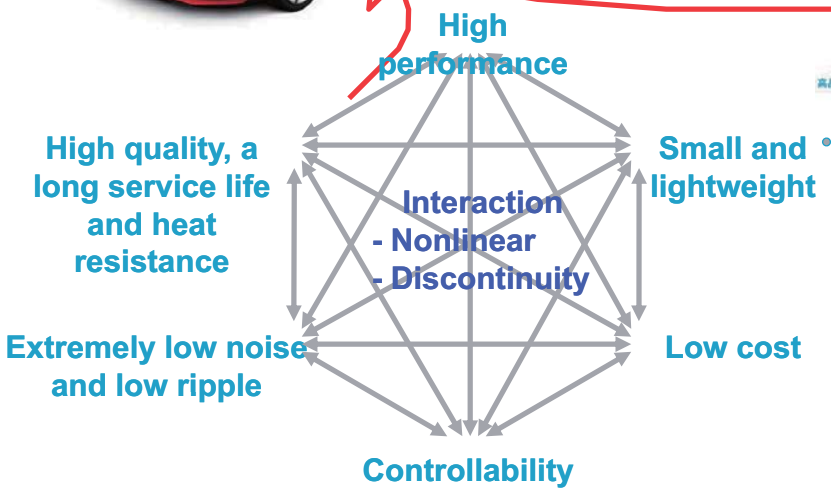
Expectations for MBD 1 (concept design)

-Methodology for pursuing limit design for customers

•Shared terms for engineers: Numbers/mathematics

•Dynamic characteristic expression method: Behavior model



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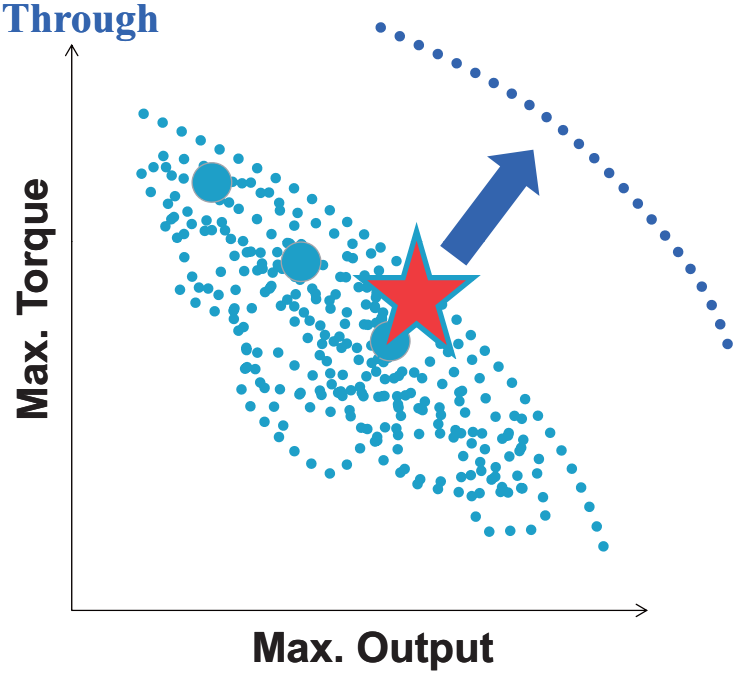
Expectations for MBD (unit development phase)

- Quantifying constraints ->Pursuing next limit designs -> Break Through



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Target

What do we want to do

with power electronics systems?

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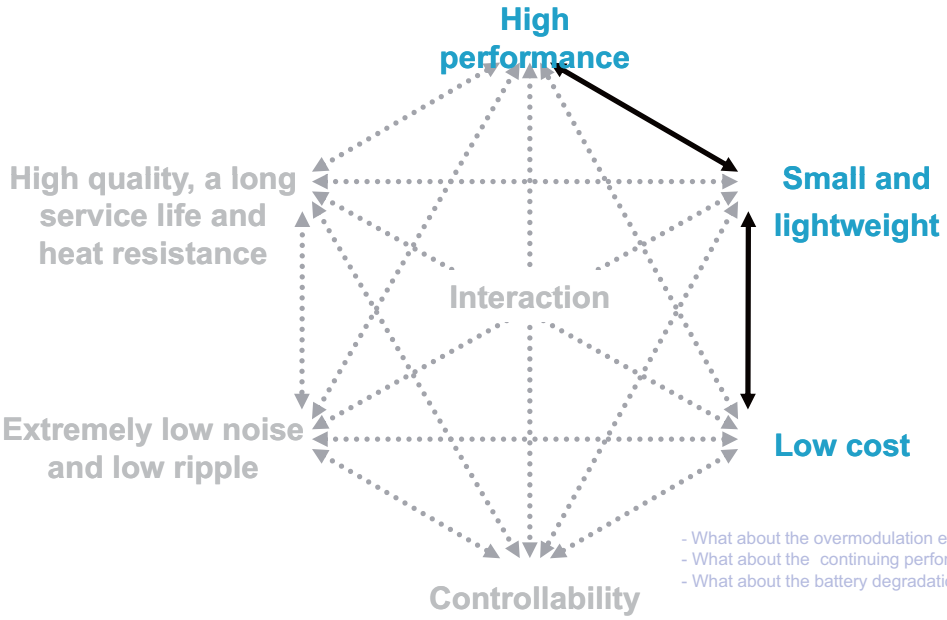
The Pros and Cons of JMAG-Studio

- JMAG-Studio allows you to find out the instantaneous torque characteristics in a motor for the ideal current conditions in a short period of time.



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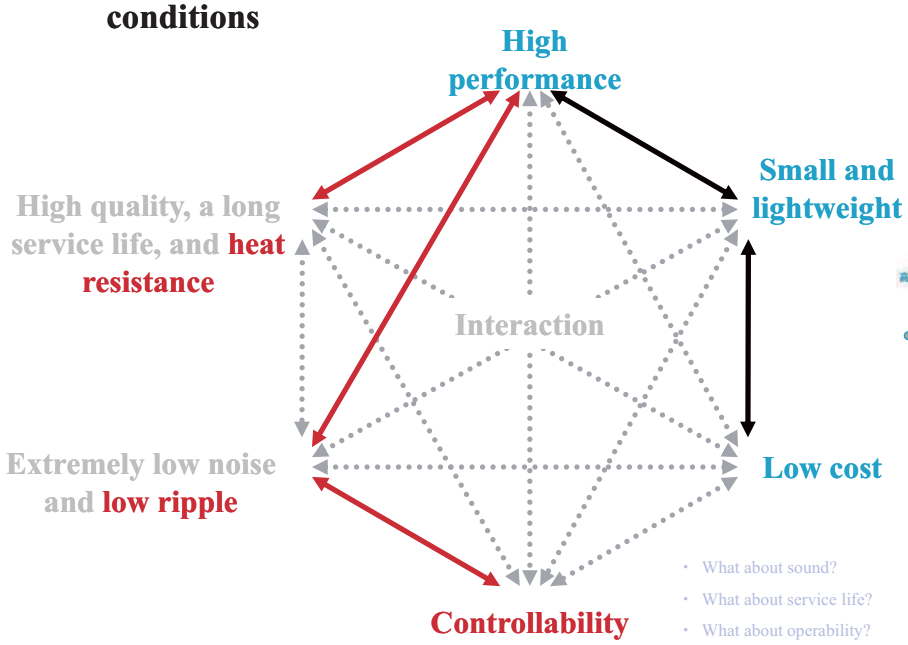
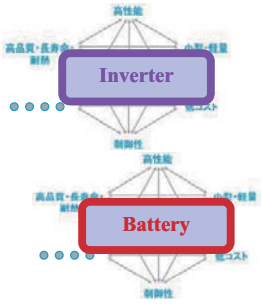
The Pros and Cons of JMAG-RT

- **The calculations take time, but you find out the time rating performance in the entire electric drive system for the real current conditions**





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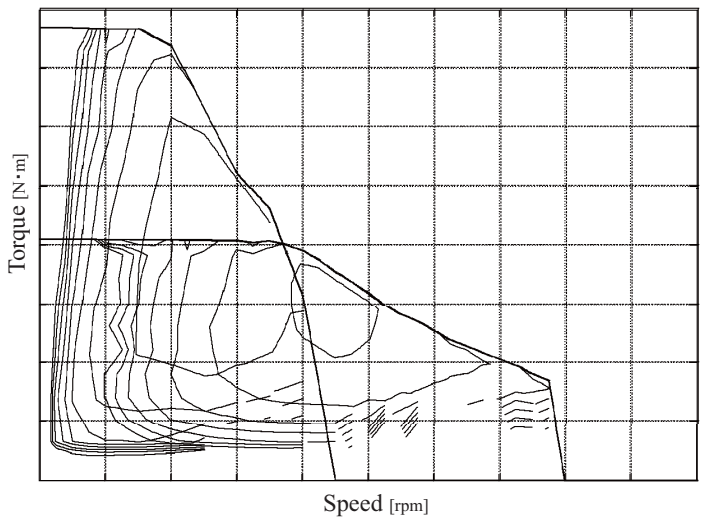
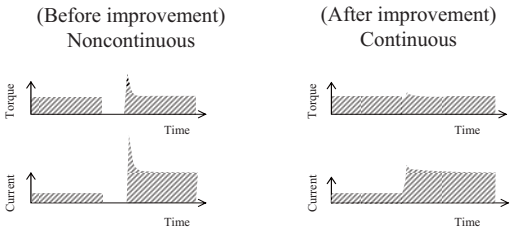
Aim: Premacy Hydrogen RE Hybrid

•Choosing the Mazda Dual Mode Drive System



High torque × electric transmission



Performance mode changes in torque continuity

(Source) JSAE 20104603 Vol.41, No.5, September 2010. Development of Automotive Wide Range Motor Drive Systems

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Methodology

How can we make it come true?

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Calculation System Structure

① PCs (Pre and post processing)

modeFRONTIER 4.1

Windows, 64Bit, Intel Xeon 1CPU Dual Core, 8GB RAM, 3GHz

② Supercomputers (Solver group)

Linux, Intel(R) Xeon(R) CPU X5272, 4GB RAM/Core, 2.93GHz

JMAG Motor Template 2.0

JMAG-Studio 10.0 with RT

Matlab/Simulink

③ Storage

Temporary 4TB, Storage 500GB

CSV, Mat files, etc.

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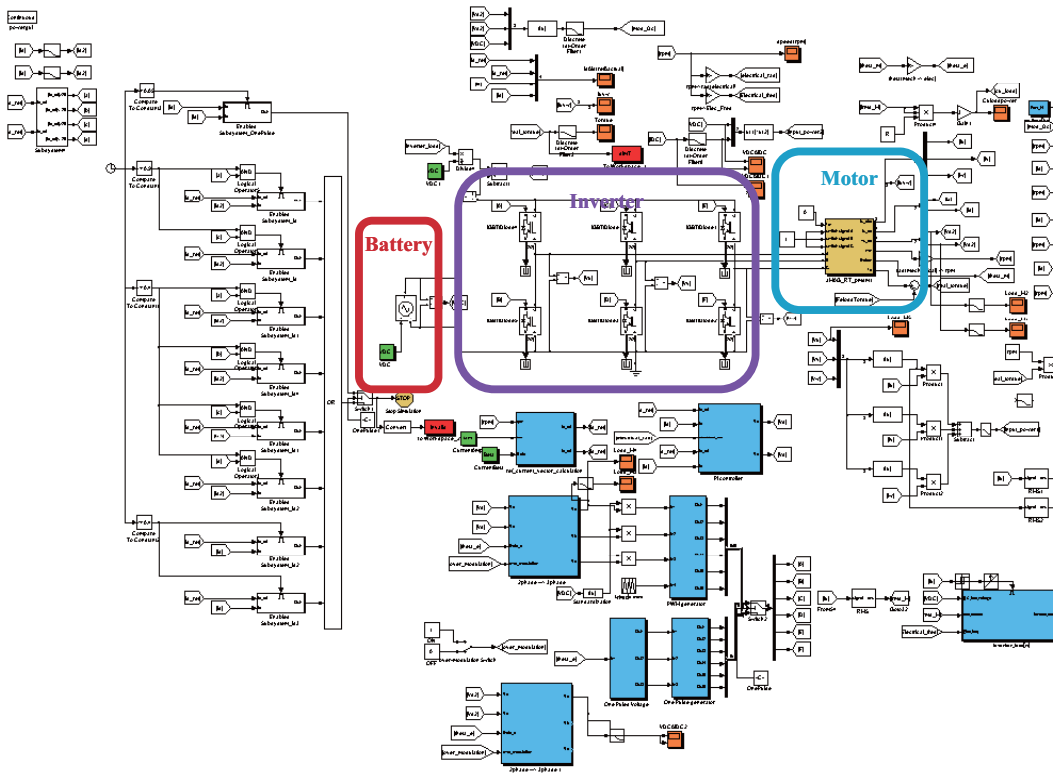
Power Electronics System Models



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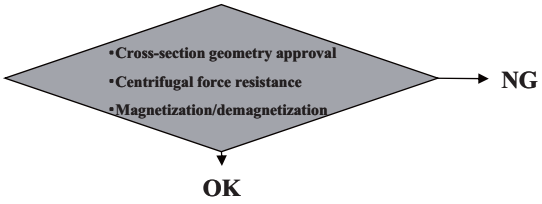
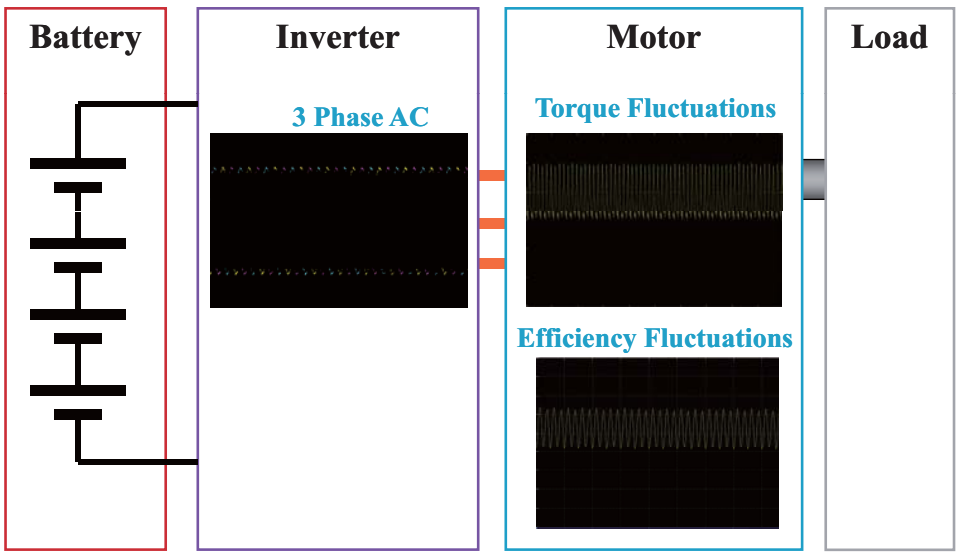
An outline of the property calculation flow

① Desktop prototype



② Desktop experiment



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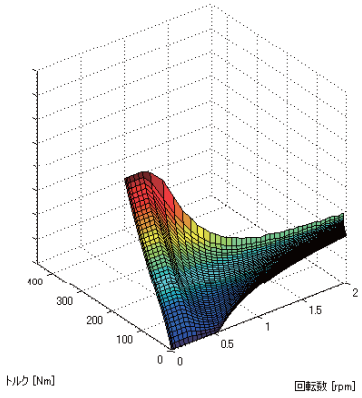
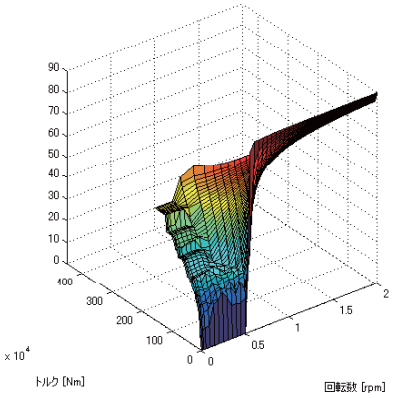
Output Data Image

・Output, routine storage, and deletion of large quantities of information

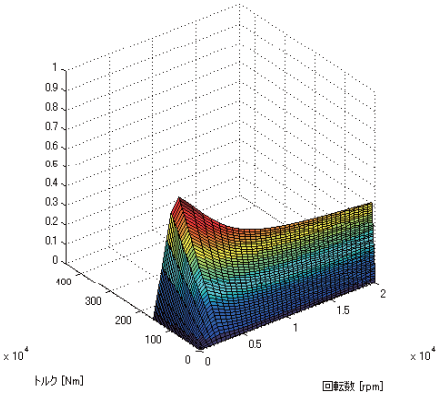
Current vector length



Electric current phase



Power factor



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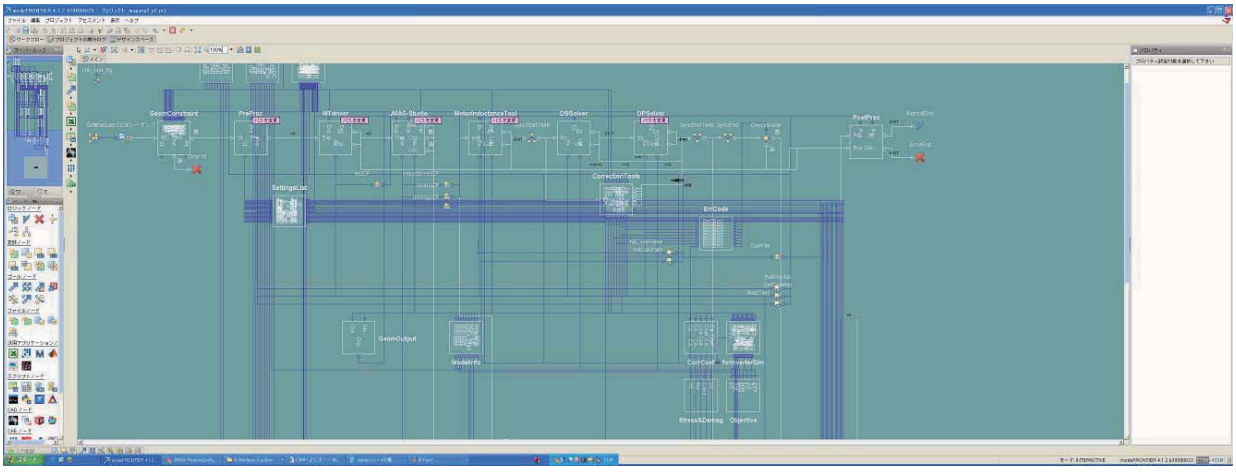
Management Software for the Total Cycle Calculation Process

・Optimization/boundary visualization/decision making: modeFRONTIER

-Evaluations based on object functions

-Parameter studies within constraint conditions



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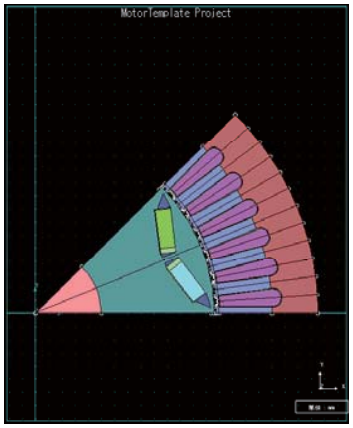
Transformations in Motor Cross-section Geometry

- **Actively studying more complete designs.**

-Experimentation planning approaches

-Genetic algorithms

-Game theory



Primitive design

Evolutionary algorithms

The evolved design

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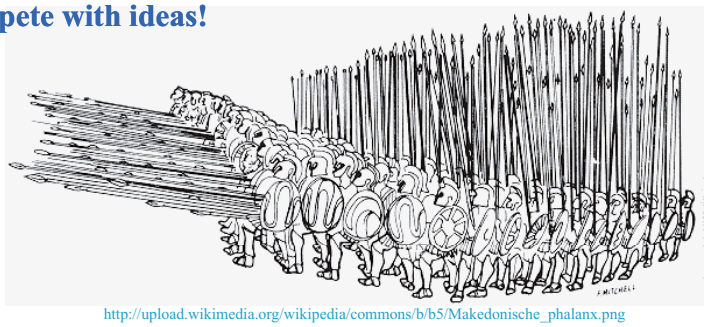
Phalanx System

- **Operations that require power are left to machines, while human beings compete with ideas!**



http://upload.wikimedia.org/wikipedia/commons/b/b5/Makedonische_phalanx.png

http://ja.wikipedia.org/wiki/%E3%83%95%E3%82%A1%E3%82%A4%E3%83%AB:Phalanx_CIWS_test_fire_-_081107-N-5416W-003.jpg

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Results

What were we able to do?

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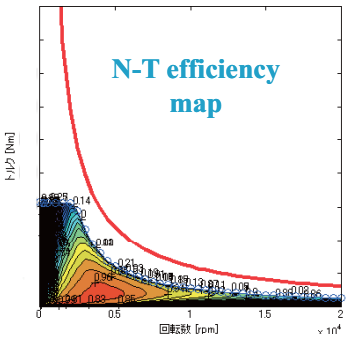
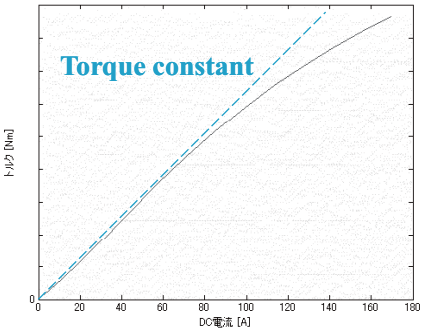
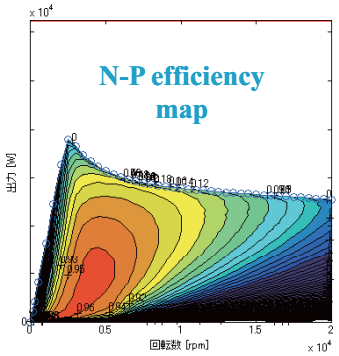
An Output Example for One Design

- **A detailed desktop experiment report remains for each entire design.**







※ Follow-ups for post processing and editing are simple

※ It is possible to set objectives for new developments

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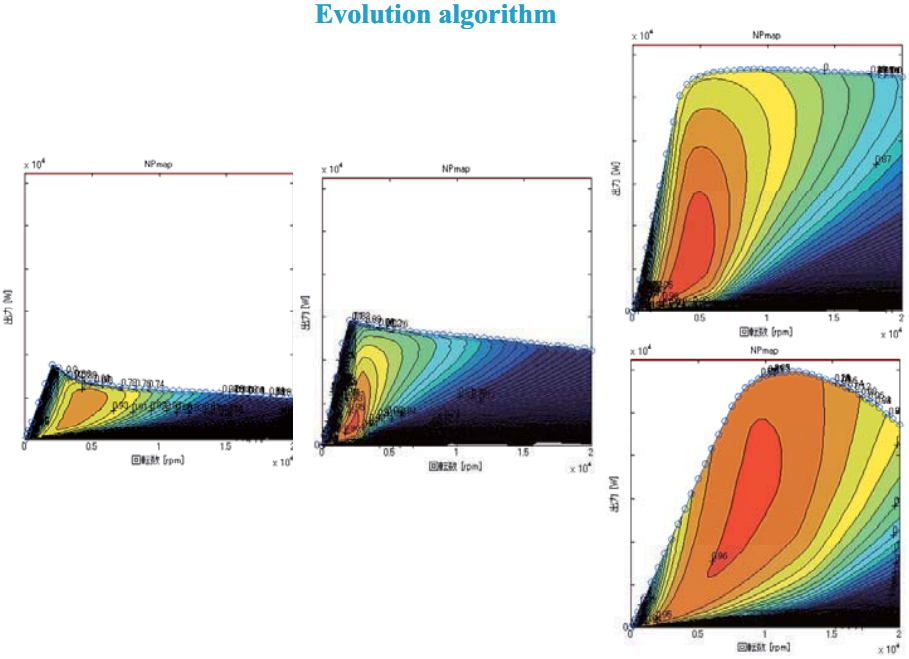
A Characteristic Improvement Example

- **An example of setting objectives after-the-fact.**

Primitive design → **Evolution algorithm** → **Evolved design**



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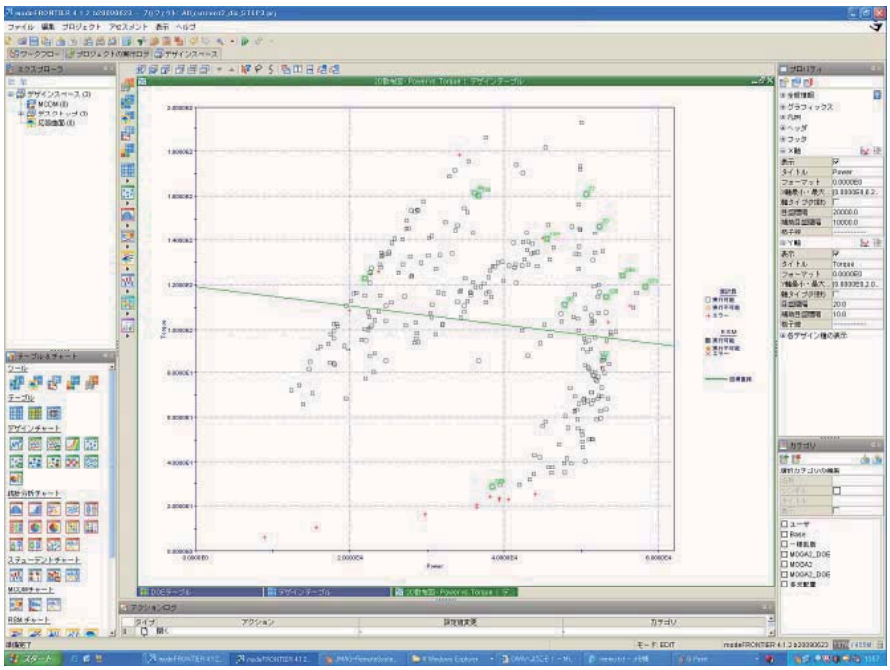
Process 1

- **1st experimentation planning approach (Obtaining high correlation factors with the smallest possible study)**



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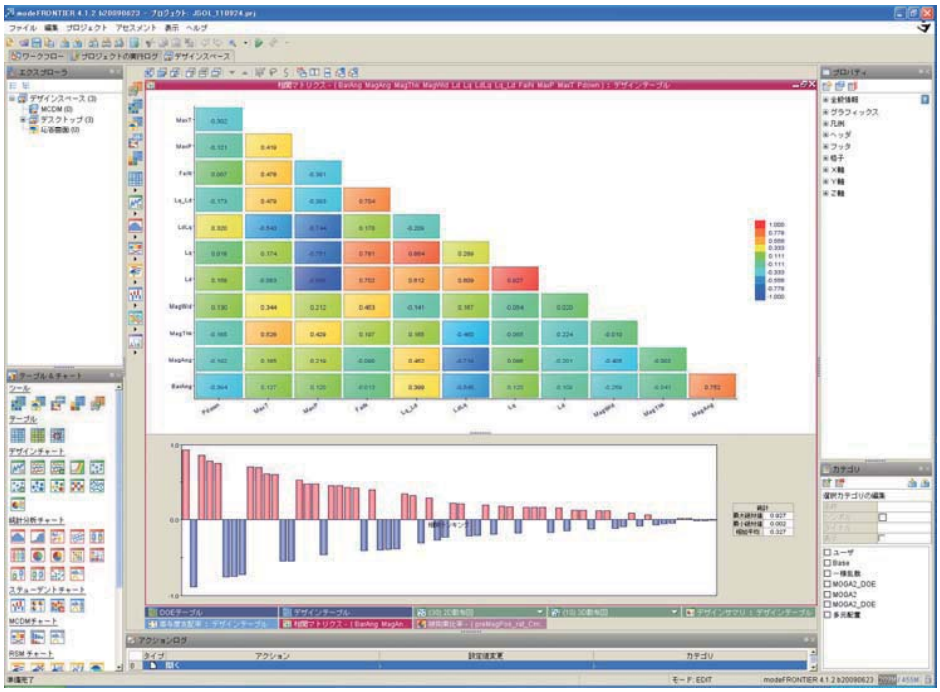
Process 2

- Take note of the major contributing factors and study them



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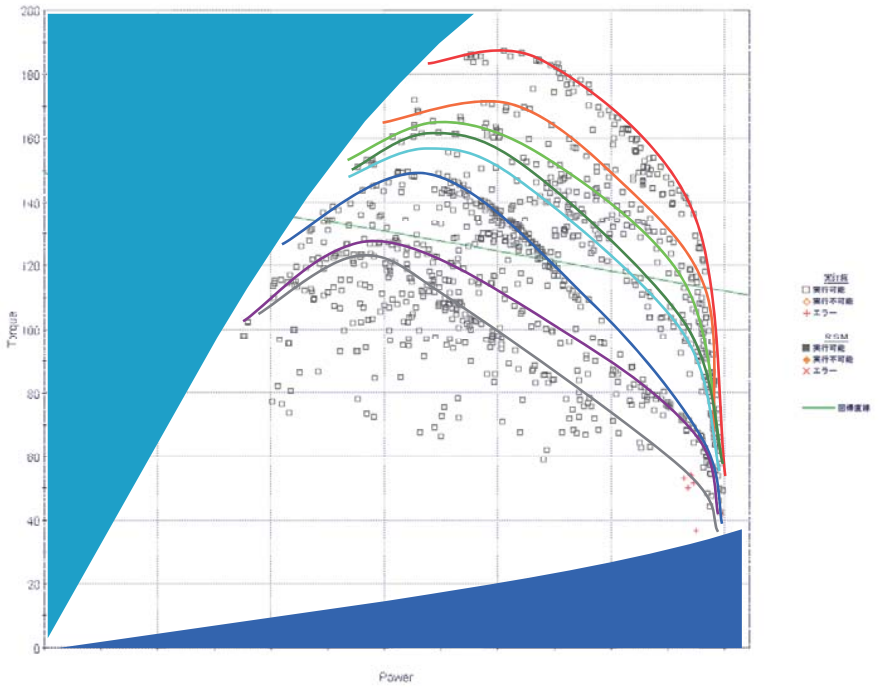
Process 3

- A concentrated search near the limits with genetic algorithms ⇒ Wall



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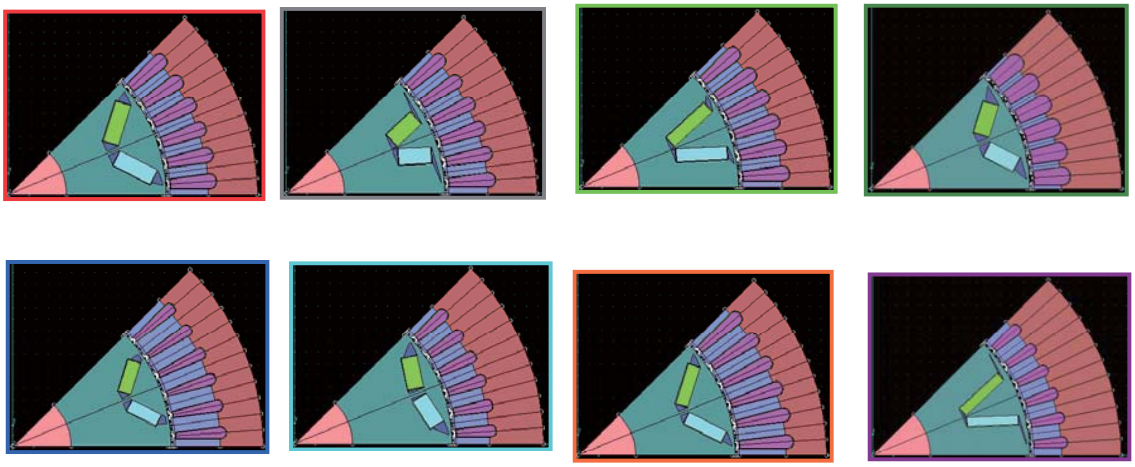
Verification 1

- **Typological understanding of an enormous design group**



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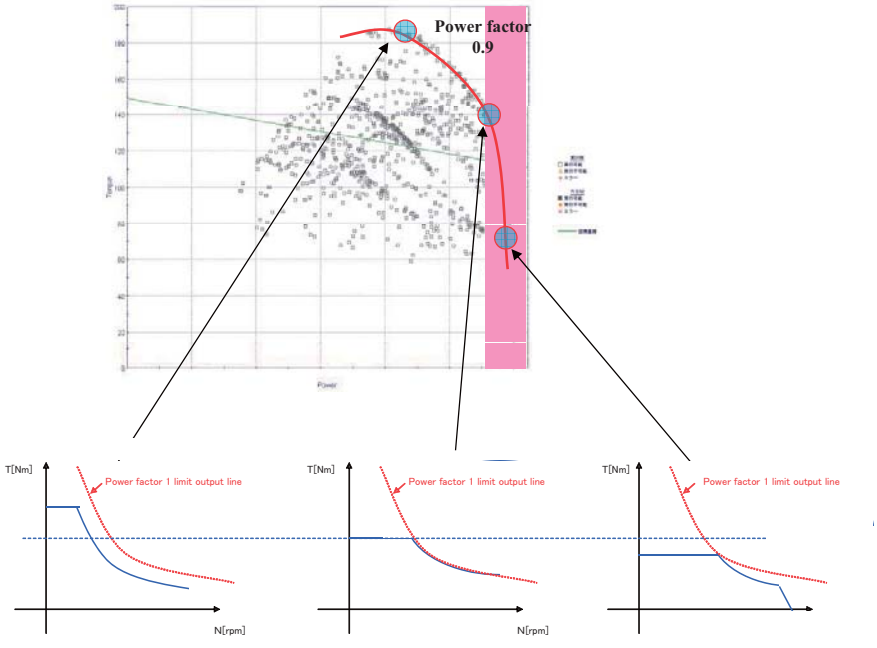
Verification 2

- **Theoretical organization and systemization**



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Future Prospects

How do we develop it further moving forward?

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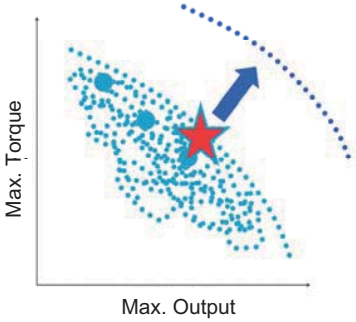
Application for Limit Design (An Example)

- **Visualization of (multiple) heat constraints in the system interior**
- **Visualization of battery voltage dip phenomena during full acceleration**
- **Transitioning to Computer Aided Principle Design**

Break Through



Limit Design

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Q & A

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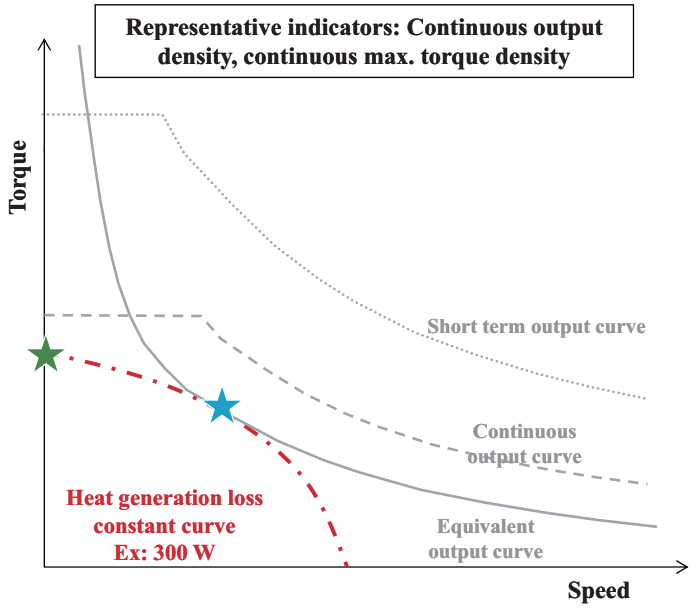
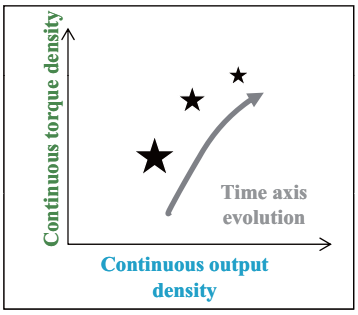
Proposal

① Shall we aggregate measures to discuss the relative merits of motors?
② Could we receive technology proposals with dynamic models (JMAG-RT)?





- The effects from a nominal machine disappear ⇔ needs consideration
- Temporal/thermal fair ⇔ the gap in heat dissipation ability disappears
- Competing with the motor ⇔ not competing with the system

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