TOSHIBA REVIEW

2014 VOL.69 NO.9

Special Reports

Simulation Technologies Supporting Design for X (DFX)

Realization of DFX Aimed at Value Creation and Productivity Improvement
MORI Ikuo

Simulation Technologies Bringing Innovation to Manufacturing Engineering and Optimization of Design and Manufacturing Processes
NAKAGAWA Yasutada / KUBO Tomoaki
In the field of manufacturing engineering, a variety of simulation technologies are playing a critical role not only in design for manufacturability (DFM) in the product design phase, but also in design for X (DFX) in a broad range of design phases from transportation through to installation, operation, and maintenance of the product. These simulation technologies make it possible to logically and efficiently optimize the design and manufacturing processes through the virtual manufacturing of products.
Toshiba is vigorously promoting the innovation of simulation technologies for manufacturing engineering from production line design to the optimization of manufacturing processes including machining, assembly, evaluation, and inspection.

Application of Production Simulation Technologies to Production Line Design and Production Forecasting
KOTAKE Masahiro / SUGIYAMA Naomi
In order to improve productivity, Toshiba has been devoting continuous efforts to process innovation activities in its overall business operations including production lines based on the reconstruction of current operations and redefinition of contribution criteria and indicators. It is important for the acceleration of innovation activities to implement potential risk assessment prior to the commencement of mass production at the product planning and development phases.
As a solution to this issue, we have developed production line design and production forecasting technologies utilizing production simulation technologies and have been applying these technologies to the construction of optimal production lines for a wide variety of products, including digital products, semiconductor devices, and products for social infrastructure systems. We are further advancing these technologies and promoting the expansion of their areas of application from conventional products to those in service business fields.

Heat Radiation Design Technology for LED Lighting Systems Utilizing Thermal Simulation
INOUE Michinobu / SO Mayumi
In recent years, the replacement of conventional lighting with light-emitting diode (LED) lighting systems providing higher luminous efficiency has been accelerating in various lighting fields. For the timely introduction of new LED products on the market, it is necessary to efficiently determine their specifications by performing heat radiation design, which is one of the technical issues in LED lighting systems. Thermal simulation using three-dimensional computer-aided design (3D CAD) can facilitate effective planning of countermeasures and verification with respect to technical issues identified at the initial stage of development.
Toshiba has developed a heat radiation design technology for LED lighting systems utilizing thermal simulation, which can evaluate the temperature characteristics of the detailed parts of an LED lighting system through simulation models taking into consideration the luminous efficiency, temperature dependence of the voltage, and heat transfer structure of the power supply unit. This technology makes it possible to identify parts whose cooling is difficult prior to prototype production and determine specifications achieving a balance between heat radiation performance and the targeted brightness and product cost.

Technology for Structural Reliability Prediction at Conceptual Design Phase of Outdoor Facilities
OGAWA Takayuki / SHINOZUKA Hiroshi
In order to ensure the structural reliability of outdoor facilities, including wind turbine systems, solar panel arrays, and lighting units, it is essential to take the effect of wind at the installation site into consideration in their design. Technologies to estimate reliability from the conceptual design phase having high design flexibility, as well as technologies to quantitatively estimate the load generated during the operating lifetime of a facility, contribute to shortening of the development period by performing overall optimization in consideration of performance, cost, and reliability.
Toshiba has developed a technology to quantitatively estimate the vibration load of outdoor facilities under windy conditions based on a fluid-structure coupled simulation method. Employing this technology, we have also developed a tool that makes it possible to quickly and easily perform structural reliability prediction for outdoor facilities at the conceptual design phase. Through the application of this technology and tool to product design, we have confirmed that the development period of such outdoor facilities can be shortened.

Appearance Reproduction Simulation Technology for Lighting and Home Appliance Products
SUZUKI Hiromi
Ray-tracing simulation is used to design lighting equipment for the estimation of performance characteristics, including the illuminated area, brightness, and color of the object of illumination, without trial production. However, as it is difficult to simulate the appearance of lighting equipment itself in terms of how it is perceived by the human eye, confirmation of its appearance through prototype models is required.
Toshiba has developed an appearance reproduction simulation technology for lighting and home appliance products, which can reproduce the appearance of a product itself taking into consideration the characteristics of both the human eye and the display used for displaying the results obtained by the simulation. This technology is expected to contribute to the reduction of production lead times by allowing the product appearance to be evaluated without trial production, and to assist in promoting product quality in sales activities.

Ultrasonic Simulation Technology for Nondestructive Testing
NISHINO Tomoko
Inspection and measurement methods using ultrasonic waves including ultrasonic testing are widely used for the nondestructive testing of structures and metal welds. Due to the difficulty of discriminating whether the echoes are reflected from the target or other portions of a test object, however, experienced engineers are required in order to satisfactorily utilize these methods.
To solve this issue, Toshiba has developed an ultrasonic simulation technology that makes it possible to visualize the propagation behavior of ultrasonic waves, and constructed a mechanism for improved analysis of the resultant data. We have applied this technology to defect inspection in structures and the measurement of laser-welded joints, and confirmed the effectiveness of visualization by means of such simulation.

Virtual Verification System for Automatic Optimization of PMSM Control Parameters
SUZUKI Nobuyuki / SAITO Toru
In order to realize energy-saving home appliances from the standpoint of global environmental awareness, an increasing number of products are equipped with a permanent magnet synchronous motor (PMSM) driven by an inverter on which a microcomputer is mounted to control the PMSM. Software incorporated in the microcomputer is required to optimize the control parameters that affect the responsiveness and efficiency of the PMSM.
Toshiba has established a development environment for software to automatically optimize PMSM control parameters by constructing a virtual verification system for PMSMs. This system assures software quality and improves the efficiency of development of PMSM drive systems for home appliances.

Feature Articles

Workfunction Engineering for New Carbon Allotropes Utilizing First-Principles Calculation
YOSHIDA Takashi
Graphene is a crystalline allotrope of carbon that has been attracting increasing research interest due to its potential as a transparent electroconductive material consisting of a thin monatomic layer. Efforts are being made to utilize it in a wide variety of applications.
Toshiba is working toward the practical realization of graphene devices including a transparent electrode and a wire for nanoscale devices. In order to obtain knowledge of the workfunction of graphene materials, which is a key physical parameter corresponding to the contact resistance between a metal and graphene material, we have conducted simulation experiments on the workfunctions of nitrogen (N)- and boron (B)-substituted graphenes utilizing first-principles calculation. As a result, we have found that the workfunction of N-substituted graphene is reduced by almost 20% compared with that of normal graphene, while that of B-substituted graphene is increased by approximately 20%. The workfunction is also affected by the substitution position of N atoms. Through these results of our simulation study, we have confirmed that the workfunction of graphene materials can be controlled.

EH800 AC Electric Locomotive for Japan Freight Railway Company
YAMADA Masahiro
On the Kaikyo Line connecting Honshu and Hokkaido via the Seikan Tunnel, there are plans for sharing of tracks with the Hokkaido Shinkansen due to the construction of a new railway station provisionally named Shin-Hakodate.
In cooperation with Japan Freight Railway Company, Toshiba has developed a prototype of the EH800 AC electric locomotive that can be driven at catenary voltages of both 25 kV AC (shared line section) and 20 kV AC (existing line section). To secure safety and functionality, the EH800 is equipped with an L-shaped guide for derailment prevention, as well as axle temperature sensors and vibration sensors. It is also equipped with electrical equipment that has already been proven in past Shinkansen projects, including a type of digital automatic train control (ATC) system called the DS-ATC, which will continue to be used as the conventional automatic train control-locomotive (ATC-L) system for the time being, and a digital wireless radio device.

High-Efficiency Auxiliary Power Supply System for Rolling Stock Applying All-SiC Devices to Inverter Circuits
KAWAMURA Koki / MAKI Koji / KOIZUMI Satoshi
The advancements in the performance and sophistication of rolling stock in recent years have given rise to the need for auxiliary power supply units with larger capacity, higher efficiency, and smaller size.
To meet these market requirements, Toshiba has developed a new type of auxiliary power supply system for rolling stock consisting of an auxiliary power supply unit , in which the output voltage is changed from the conventional three-phase AC to DC voltage, and an air-conditioning unit, which is the component that conventionally places the highest power consumption burden on an auxiliary power supply system. This system was developed applying our high-voltage, high-current, and low-loss all-silicon carbide (SiC) devices capable of high-frequency switching, including SiC power metal-oxide-semiconductor field-effect transistors (MOSFETs) and SiC Schottky barrier diodes (SBDs), to high-frequency inverter circuits. The auxiliary power supply unit achieves high efficiency and compactness due to the development of a compact high-frequency isolation transformer while maintaining the conventional output capacity, and the air-conditioning unit achieves a reduction in power consumption due to the adoption of rotation speed control using an inverter drive for the compressor instead of conventional on/off control.

Energy Management System for Expressways to Systematically Control Charging Demand for EVs and Total Electricity Supply and Demand
NAKAMURA Junichi / YAMADA Hisashi / KANO Makoto
An energy management system (EMS) for expressways is an integrated management system for the optimization of road traffic utilizing intelligent transport systems (ITS) as well as for efficient energy utilization. Accompanying the dissemination of electric vehicles (EVs), this system contributes not only to the mitigation of expressway traffic congestion arising from the charging of EV batteries but also to the improvement of energy conservation and reduction of impacts on the environment. Focusing on EVs and charging stations at each service area/parking area (SA/PA) of an expressway, Toshiba has now developed algorithms and simulators for the ITS center and EMS center that form the main subsystems of the EMS for expressways. We have conducted simulation experiments and confirmed that the EMS for expressways can level the number of EVs requiring charging between each SA/PA, thus effectively shortening the waiting time of EVs at the charging stations through the use of these algorithms.

"RENECAT™" Visible-Light-Responding Photocatalyst to Improve Indoor Air Quality
SATO Akira / YOSHIDA Kayo / FUKUSHI Daisuke
In recent years, attention has become increasingly focused on health and safety, particularly in relation to food, water, and air. With regard to air, there is growing awareness of odors in daily life as well as germs, viruses, and allergens in the atmosphere, in addition to air pollution from the diffusion of volatile organic compounds (VOCs) and particulate matter of 2.5 μm or less in diameter (PM 2.5).
Toshiba Materials Co., Ltd. has developed a new visible-light-responding catalyst called "RENECAT™," based on technologies acquired through the development of both materials and nanomaterials. RENECAT™ can effectively decompose and remove substances that are a source of odor, germs, and viruses by using indoor lighting, and is expected to contribute to safe, secure, and comfortable indoor environments through application to a wide variety of products.

3G/LTE Antenna Packaging Technology with High Performance and Easy Tuning Function for Notebook PCs and Tablets
KASHIWAGI Ippei / TSUJIMURA Akihiro
The expanding dissemination of 2-in-1 notebook PCs and tablets in recent years has increased the complexity of their embedded antennas to meet various requirements including complicated structures and stylish designs. In particular, as third-generation (3G)/LTE (Long Term Evolution) systems require a very wide frequency band for worldwide support, customized design of high-performance antennas has become essential to optimize the performance of each type of device.
Toshiba has developed a technology for 3G/LTE antenna systems embedded in its notebook PCs and tablets incorporating the following technological advancements: (1) high performance in low-frequency regions, (2) a wide bandwidth supporting high-frequency regions, and (3) a function that independently facilitates tuning in each frequency region. This technology has been rapidly applied on a wide scale to our Portégé series and Tecra series products for overseas markets.

Frontiers of Research & Development

Energy-Saving Smart House with Capability to Set Acceptable Heating Temperature Based on Survival Analysis