TOSHIBA REVIEW
2005. VOL.60 NO.1

Special Reports-1

HD DVD Core Technologies

HD DVD Core Technologies for New Innovations
ARINOBU Mutsuhiro

Trends in HD DVD Core Technologies
NAITO Katsuyuki / TANAKA Masahiko / ONOMURA Masaaki / ASHIDA Sumio / YONEZAWA Minoru / YAMAKAGE Tomoo / KASHIHARA Yutaka
The concept of HD DVD is maintaining compatibility with conventional DVDs, easy operability by users, low disc manufacturing cost, and large storage capacity. The disc is manufactured by a process similar to that for DVDs (adhering two substrates together), so that both DVDs and HD DVDs can be produced on a single production line. The positions of the disc and the light spot are precisely controlled. A blue-violet laser diode is used as the light source to project a small light spot on the disc medium to read and/or record the signal. Moving picture data are compressed by the latest video coding standard, allowing more than 8 hours of high-definition movies to be enjoyed on a 30 Gbytes double-layer ROM disc.

This paper introduces the trends in these core technologies and provides a brief history of optical disc development and standardization.

Blue-Violet Semiconductor Laser Diodes
ONOMURA Masaaki
Blue-violet laser diodes (LDs) with a wavelength of 405 nm are indispensable as a light source for HD DVD systems. Toshiba has developed InGaN-based multi-quantum-well LDs with ridge waveguide structures on GaN substrates using metal organic chemical vapor deposition (MOCVD). The threshold current was 39 mA, the operating current was 73 mA at an output power of 50 mW, and the slope efficiency was 1.47 W/A under continuous-wave (CW) operation at 25 °C. The characteristic temperature between 25 °C and 75 °C was 172 K. The temperature dependence of the wavelength shift was as small as 0.053 nm/K, and the output power dependence was 0.16 nm/mW. A kink-free output power of 100 mW was obtained under pulsed operation in the temperature range between 25 °C and 75 °C, and stable laser operation was confirmed under 100 mW pulsed operation at 75 °C.

The characteristics of these high-performance blue-violet LDs make them suitable for use as a light source in next-generation DVD systems such as HD DVD.

Recording Media Technologies for HD DVD
ASHIDA Sumio
The HD DVD specifications have been authorized for each of the read-only, write-once, and rewritable type media. Each type has sufficient recording capacity to record high-definition moving pictures, while the current production processes can be applied with minimal change.

This paper discusses the new technologies involved in the media to satisfy these requirements. They include the development of material suitable for the blue-violet laser and novel design of optical and thermal properties.

Video Coding Technologies for HD DVD-Video
YAMAKAGE Tomoo / CHUJOH Takeshi / KOTO Shinichiro
Advanced video coding technologies such as MPEG-4 AVC/H. 264 and VC-1 have been adopted as HD DVD-Video specifications in addition to MPEG-2. The combination of advanced video coding technologies and HD DVD discs makes it possible to provide superior picture quality compared to existing digital broadcasting. However, because of the increase in computational complexity, especially for encoding, it is essential to reduce such computational complexity in implementing the encoder.

Toshiba has developed a fast coding mode decision method and a fast bit-rate estimation method, which achieve complexity reduction for MPEG-4 AVC/H. 264 encoding.

Mechanical and Servo System Technologies for HD DVD Drives
YONEZAWA Minoru
HD DVD is the next-generation DVD, whose systems are compatible with the DVD systems. The mechanical and servo technologies for HD DVD drives can also be realized based on the mechanism and technologies adopted in conventional DVD drives.

Toshiba has developed a prototype HD DVD player equipped with an HD DVD drive and verified the performance of the drive. The results of the verification proved the applicability of the mechanical and servo technologies of conventional DVD drives.

Signal Processing Technology for HD DVD
KASHIHARA Yutaka
HD DVD was developed as the next-generation DVD to record high-definition movies. Two key technologies achieve the capacity demanded for HD DVD: the blue-violet laser diode, and partial response maximum likelihood (PRML) signal processing. Although there is a relative increase in the noise level in high-density recording, data can be reproduced correctly using PRML. Furthermore, adaptive equalizing enables PRML to display its capability to the full by reducing effects caused by unevenness of discs, the pickup head, and so on.

Special Reports-2

Design for X (DfX)

Goal of DfX: Establishment and Practice of Product Definition
ISHII Kosuke

Importance of Upstream Design in Product Development and Its Methodologies
OHTOMI Koichi
It is said that 80 % of all life-cycle costs of a product are fixed at the product planning and design stages. Design is thus an important element of product development. On the other hand, the design greatly depends on the designer's abilities, and so-called standardization is insufficient. It is therefore necessary to clarify what the requirements are at the design stage in order to develop a product strategically and efficiently.

This paper introduces the Design for X (DfX) methodology for strategic product development. DfX is a systematic activity at the planning to conceptualization stages of product development that (1) analyzes the nature of the project, (2) identifies effective design tools and activities (the "X" in "DfX"), and (3) guides the deployment of these tools in the subsequent development stages.

Product Planning Process Based on Voice of Customer
KYOYA Yuji / NOGUCHI Kunio / NAKANO Takashi
Products with numerous functions or high performance do not always satisfy customers. In order to develop successful products, it is essential to ask: "Who are our customers?" "What do they want?" and "How can we implement their requirements in our product?" Quality function deployment (QFD) is one of the major tools available for transforming customers' requirements into goal specifications.

Toshiba has developed a product planning process based on the voice of customer (VoC) principle centering around QFD as a core tool, and has also developed supporting tools. This process has been widely introduced in Toshiba and applied to many product development projects.

Approach for Quantitative Estimation of Design Load and Efficiency
OZAWA Masanori
The importance of performance evaluation at the early stages of product design has been widely acknowledged empirically and intuitively. However, few studies discuss this subject based on quantitative indices.

In this paper, Toshiba proposes a methodology to measure the load and the efficiency of design by introducing basic information theory. We have applied this methodology to the analysis of actual design processes.

Design Methodology for Optimizing Product Development Processes and Organizations
MORI Toshiki
Significant changes have taken place in product development in recent years, including enlargement of the scale of system design, tough time-to-market (TTM) competition, and cost reduction. As a result of these changes, it is necessary to innovate product development processes as well as organizations from the viewpoint of global optimization. The design structure matrix (DSM) is a systematic methodology for the design of efficient processes and organizations.

Toshiba has developed a DSM tool called MTP (Matrix-based Task Planner) to support in-house projects for the innovation of product development processes. From this experience, we learned important lessons for the effective use of DSM such as clarifying its target and task definitions, paying attention to task sizes, and focusing on actual status and information flow.

Trade-off Analysis Method
KUROIWA Tadashi
In order to promote strategic product development, it is important to establish a design proposal promptly after setting exact goals for a product's functions, performance, and cost. For this purpose, the trade-off analysis method, in which alternative designs or methods are weighed (trade-off analysis) at an earlier stage of design, is now reaching a practical level aided by developments in simulation technology and multi-objective optimization technology.

We have confirmed the effectiveness of the trade-off analysis method by applying it in a case study to an earlier stage of the product development and design processes.

Steam Turbine Development and Design Using Strategic Processes
SASAKI Takashi / SUZUKI Takashi / TANUMA Tadashi
The most important customer requirement in steam turbine design is the reduction of life-cycle costs from the introduction of a new unit, construction, business operation, overhauling, and retrofitting through to its decommissioning. In addition, the specific requirements of each customer are also important.

Toshiba is introducing strategic processes of development and design for the life-cycle optimization of steam turbines. Joint development and manufacturing of a core component with General Electric Co. of the United States has been successfully completed. Toshiba is also introducing digital manufacturing systems for steam turbines in a digital data stream from the design process to manufacturing.

Eco-design Support Based on Life Cycle Approach
KOBAYASHI Hideki / KOBAYASHI Yoshinori / HATANAKA Hideharu
Environmentally conscious design (sometimes called eco-design) is essential in realizing sustainable manufacturing. Several years ago, Toshiba developed design methods and tools to support eco-design based on a life cycle approach, and we have applied them to our in-house product development processes. The product life cycle planning (LCP) method serves to establish a design concept incorporating the "3Rs" (reduce, reuse, and recycle). Life cycle assessment (LCA), by which the environmental burden of a product life cycle is quantified, enables integrated environmental damage to be estimated. Our eco-efficiency index can be calculated using such LCP and LCA data.

Simulation-Based Process Innovation of Firmware Development for Electromechanical Products
KONDO Koichi / HOSHINO Susumu / MOTOHASHI Shoichi
An electromechanical product is a complicated system comprising a mechanism, firmware, and an electrical circuit. Rework in the later design stage often has a close relationship with the firmware design. Improvement of firmware design therefore has a strong impact, shortening the design process and enhancing product quality. Efficient product development can be achieved in terms of iterative design refinement and simulation-based verification from the early concept design stage to the later detailed design stage.

Toshiba has developed the VisualMech$_{TM}$ simulation tool to facilitate such design processes, and applied it to various products. In massage chair development, for example, we have substantially reduced rework by early-stage simulation-based reviews of firmware specifications.

Frontiers of Research & Development

Consumer Behavior Analysis Using Bayesian Networks
Application of Fluid Dynamics Simulation Technology toward Uprating of Nuclear Power Plants