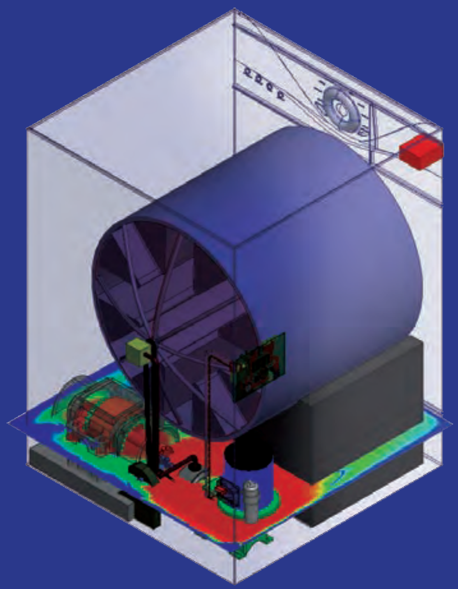
BEST PRACTICES



Cleaning Up with Systems Engineering Knowledge Management

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As products become more sophisticated and feature rich, simulation tools and design methodologies are evolving in response.

In today's complex and competitive global environment, businesses are trying to maximize shareholder value through product innovation, shorter development cycles and cost reduction to capture mind and market share. Simulation is a key driving force behind some remarkable achievements in new product development.

As organizations adopt simulation-driven design and a systems-level approach to product development, it is no longer enough to simply simulate each component in isolation. All of the components and subsystems need to be simulated together to see the effect each has on the others as well as on the whole. Ever increasing complexity in the design process and an explosion of data and methods calls for effective ways to manage simulation assets and processes as well as to enable collaboration.

The vital need, then, is for a knowledge base that manages all of the data produced by different departments, housing it in a manner that is searchable and shareable. This system must also track the use of all simulation tools and results. With such a new methodology, design teams can clean up their systems engineering approach, perform accurate simulations, and leverage existing simulation assets to shorten turnaround time.

Product design, regardless of its complexity or industry, always starts by stating the product's basic requirements. Initially, the process takes a high-level view of the entire system, identifying requirements and specifications before defining the system's specific design. From there, the design process moves to a subsystem design and finally down to engineering the detailed components. This process can involve multiple stakeholders (designers, analysts, method developers, teams and suppliers, for example), requiring the input of many different people who may be globally distributed.

With better control of simulation workflows and data, a managed and streamlined process can make an enormous difference in efficiency, accuracy and collaboration.

To explore this methodology, an example of a washing machine is presented.

Typically, a full systems-level simulation spans cases such as shocking/drop (packaging), dynamics analysis (modal and transient dynamic response), lid impact analysis, mixing (CFD) and parametric studies. This article focuses on only a subset of these steps to demonstrate the concepts.

The washing machine design example demonstrates an improved workflow that can be enabled by the ANSYS Engineering Knowledge Management (EKM) product. Each step requires input from various teams. For simulation departments seeking to reduce turnaround time, it is critical that all members of the team work with the latest version of the data and collaborate.

The topic of requirements is important. The simulation requirements (derived from the main product requirements targets) are essential and are cataloged within EKM.

A washing machine design requires the use of many different simulation tools, so tracking the results and corresponding simulation parameters generates a great deal of data.

PCB DESIGN

For this washing machine example, the critical concerns are EM interference and temperature as well as ensuring that the traces won't burn or melt by using the optimal amount of copper.

Traditional Workflow

Traditionally, to evaluate electromagnetic interference (EMI) and DC insulation resistance (IR) drop, the analyst uses ANSYS SIwave, which calculates Joule heating on the traces and exports a powermap (showing the heating on the board traces) to ANSYS Icepak to calculate the temperature of the entire PCB. The results are exported back to SIwave to determine the correct temperature-dependent electrical conductivity for the copper traces.

Once the simulation maps are completed, the PCB engineer then sends the design to the thermal analysis team to leverage Icepak, ANSYS Fluent and ANSYS Mechanical software to evaluate the power and temperature of the components. The team might study the effects of a simulated blower to determine the air flowing through the board. To keep the temperature of the copper within an acceptable range, thermal engineers might insert a heat sink. Once the thermal issues are resolved, the design is sent for structural analysis to determine vibration effects.

In this traditional design flow, the design is passed back and forth between PCB and thermal engineers several times. Without a central/federated repository for the latest files, there is no record of what changes are being made, even though it is vital that each set of engineers works with the latest files.

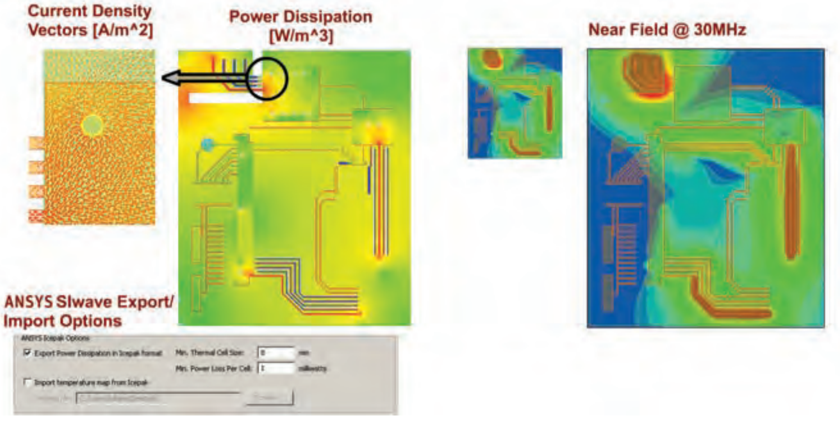
EKM Workflow

By streamlining the process based on best in-house practices, the need to manually calculate power and temperature maps between SIwave and Icepak is reduced or eliminated. Employing an Icepak macro, engineers can easily set up thermal simulations using a library of heat sinks, for example, and the library is then loaded into the EKM repository for access by anyone on the team. PCB engineers can independently estimate temperature maps by capturing the best process certified by the thermal engineer. There is no need to send and wait on data or analyses completed by the thermal engineer — which results in a dramatic reduction in development time. If later in the design process the thermal engineer determines that a heat sink is needed, the new model is uploaded and shared in EKM. The version of the file is automatically updated, and the PCB designer and structural engineer receive an automatic notification that EMI and vibration tests need to be performed with the new model. A full revision history of all files is always available in EKM. These audit capabilities increase visibility for tracking design iterations and enable informed decision-making.

PRODUCT DESIGN STEPS FOR WASHING MACHINE

DESIGN STEP	ANALYSIS REQUIRED
PCB	EMI simulation, thermal analysis, vibration analysis
Motor	Low-frequency electromagnetic analysis, thermal analysis, structural analysis, systems-level simulation
Wiring Harness	EMI simulation, signal integrity simulation
Entire Product	Systems simulation

Systems-level design is inherently multiphysics.



A PCB design requires temperature and thermal analysis to ensure correct specifications for copper traces.

MOTOR AND WIRING DESIGN

A successful motor design depends on the efficiency and effectiveness of the electronic controls that make the drum turn as well as the design of the wiring harness (the cables that power the machine and transfer digital data signals).

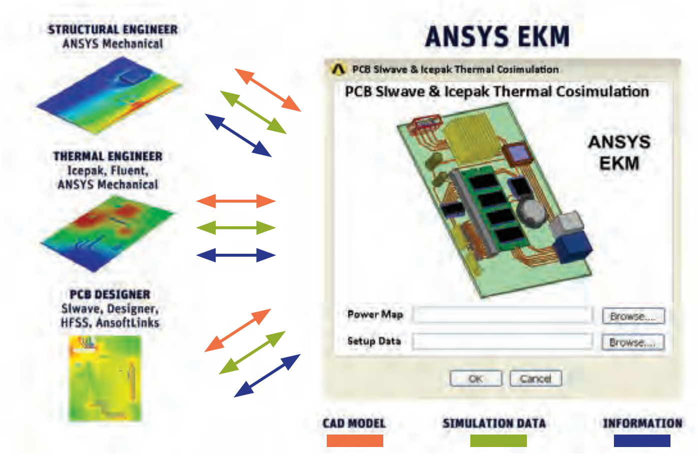
Traditional Workflow

In a traditional motor design, engineering teams simulate design iterations in ANSYS Maxwell 2-D software until an optimal design is achieved. Then, the final model is converted to 3-D and the calculated ohmic and core losses are transferred to the thermal engineer. Next, teams perform thermal and structural analysis on the temperature of the coils and motor using Maxwell 3-D solutions. Once again, engineers face the challenge of ensuring that they are using the correct motor model, since multiple models have been created.

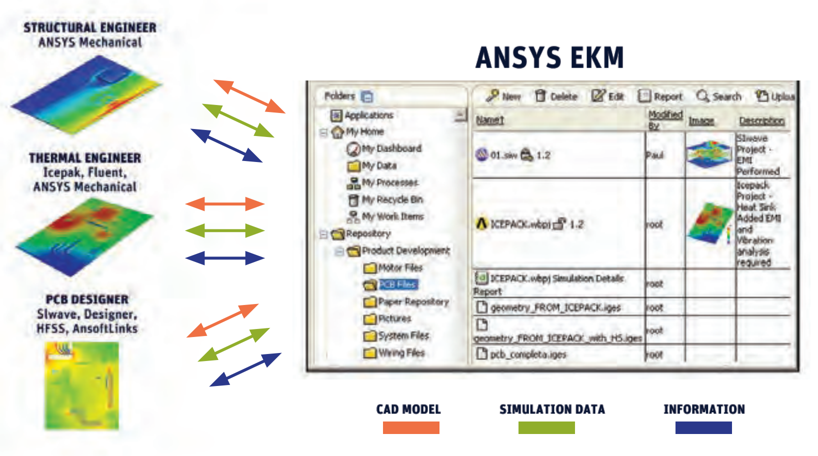
EKM Workflow

An EKM workflow of the motor multiphysics ensures that the most updated model is always available to all team members. In addition, EKM allows different teams to index, store, search, archive and re-use simulation data. When files are added, EKM automatically extracts metadata and information about the files, making it simpler to search and find them at a later date. For example, a team member could search for "motor," and EKM returns many products in the preview screen. One might be suited for use as a starting point in a new design. The engineer can use previous designs as a starting point (even if the original designer has left the company), complete with reports on the multiphysics analysis.

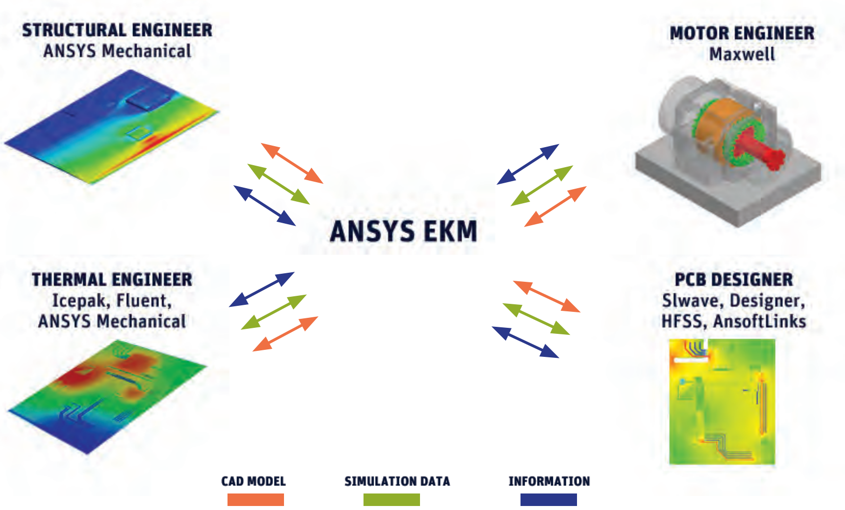
Throughout the design process, as engineers find good reference material, they can upload it to the EKM repository for other team members to access. EKM can house guidelines, product development documents, technical papers and other material. In the case of the washing machine design, engineers used the EKM resource section to help meet cabling guidelines. After designing the wiring harness, likely by leveraging ANSYS Q3D Extractor and ANSYS HFSS, the systems engineer combines the cable and motor designs to run a systems simulation typically using ANSYS Simplorer.



Cosimulation using ANSYS SIwave and ANSYS Icepak can occur in an EKM workflow.



Any changes to a model generate automatic notifications for other team members.



EKM allows PCB designers as well as thermal, structural and motor engineers to share and manage updated data during motor design.

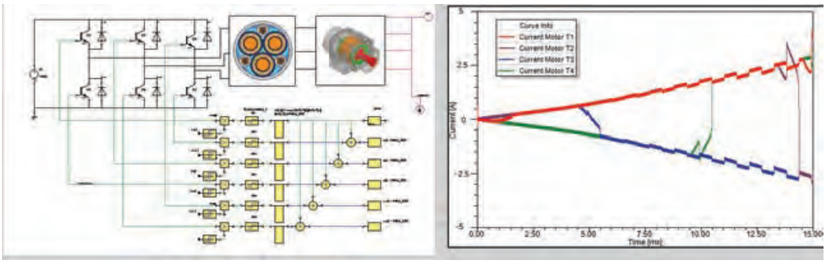
SYSTEMS SIMULATION

The final systems simulation requires CAD models from all subsystem engineers as well as simulation data from thermal, structural and systems engineers so that the electromagnetic compatibility (EMC) engineer can perform a systems simulation. At this time in the design process, there is a vast amount of data shared among many team members. EKM provides a center point for all simulation data to ensure that the correct files are advanced. The software organizes all revisions, significantly reducing errors and improving collaboration efforts.

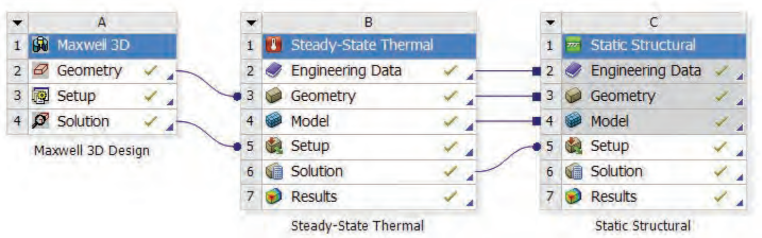
MAKING A CHANGE

In the real world, a final systems simulation is rarely the final design, and requirements can change. In the case of the washing machine example, consider this scenario: After the design was completed, the product manager determined that the washing machine should have two speeds instead of one. He uploaded the new product requirements to EKM. This design modification produces updated data, and, once the new design is updated in the database, automatic notifications are immediately sent to team members. As the new simulation workflow progresses, team members access the updated content from other engineers.

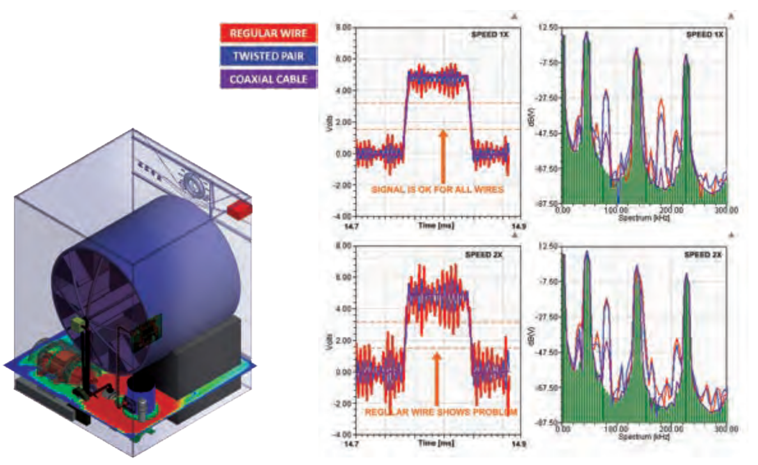
In the single-speed design, the EMC engineer used ANSYS HFSS, ANSYS DesignerSI and Simplorer to evaluate what type of wires should be used to connect the PCB to the pump. To determine the least-expensive wire type that still functioned reliably, the engineer performed immunity analysis on regular wire, a coaxial cable and a twisted pair. Simulations determined what effect the level of interference from the motor current had (if any) on the signal received by the pump. Regardless of the wire type, the electrical signal transmitted by all three wires would be the same: a 5V digital clock with a frequency of 50kHz. Analysis showed that the single-speed design could be created with any of the three wires, so the less expensive wire could be used. However, when the design changed to two speeds, this wire no longer performed in the acceptable range. Simulation revealed that changing the motor speed would require changing the type of cabling used.



Using Simplorer, it is possible to examine the current waveform on the motor. The simulations reveal motor current. The results of the current on the coils is plotted as shown (right).



ANSYS Workbench facilitates multiphysics setup.



Changing the motor to include two speeds leads to immunity problems with regular wire.

ADVANTAGES

A systems engineering approach using ANSYS EKM and the ANSYS Workbench platform ensures that analysts are performing their multiphysics (electrical, thermal, electromechanical, electromagnetic) analysis on subsystems and complete systems that are based on the most up-to-date models. This approach allows teams to work simultaneously, comparing information between numerous simulations, and using a single or linked multirepository approach to search, retrieve and re-use existing designs. The EKM product automatically indexes designs, displays preview information, and tracks revision history of simulation and other relevant files. ESSS has found that using EKM gives designers confidence that the correct files are being used and that all product requirements will be satisfied. This method creates a collaborative environment with an established workflow in which engineers can reliably optimize the final product.