SIMULIA

3DEXPERIENCE®

SIMULIA MANATEE SOFTWARE

Controlling magnetic noise & vibrations of electric machines and drives from concept to preliminary design phase

DASSAULT SYSTEMES

WHY USE MANATEE SOFTWARE?

5–20 dB
noise reduction after redesign

Full run-up computing time
< 2min

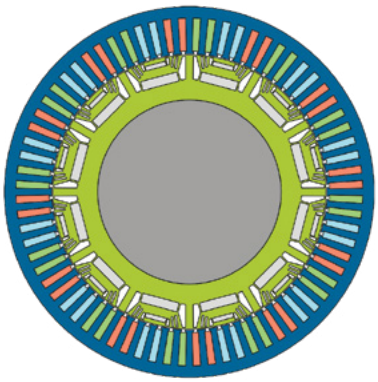
+20 years
cumulated R&D development on e-NVH

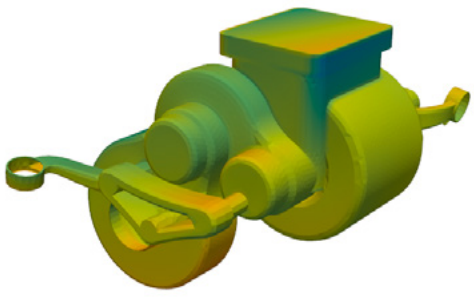
E-machines simulated with Manatee
+300

Manatee offers a **collaborative simulation and analysis environment** designed to **quickly and accurately optimize the vibro-acoustic performance of electric machines and drives under electromagnetic excitations**. Its user-friendly interface has been developed for control, electrical, mechanical and NVH engineers. Designing high-quality electric machines requires control of their acoustic noise and vibration levels at every development stage, from risk analysis in preliminary studies to vibro-acoustic troubleshooting after prototype manufacturing. Electric machines can induce significant **electromagnetic noise and vibration** (e-NVH) due to Maxwell force excitations, resulting in sound levels going up to 125 dBA at 1 meter. **All topologies of electric machines can produce health, comfort, environmental friendliness or mechanical fatigue.**

Electrical, magnetic and mechanical early design choices can have up to ±20 dB impact on magnetic noise and vibration levels. However, the prototyping and testing of electric machines are expensive and time-consuming. Manatee virtual prototyping environment increases design productivity and physical insights, **optimized electromagnetic and vibro-acoustic performance** and shorter development cycles.

FROM E-MACHINE GEOMETRY & CONTROL PARAMETERS...





...TO ELECTRIC DRIVE LEVEL ELECTROMAGNETIC NOISE AND VIBRATION

WHAT MAKES MANATEE UNIQUE?

Manatee is specialized in the calculation and analysis of electromagnetic noise and vibrations induced by rotating electric machines, including root cause analysis and noise mitigation tools.

Manatee models and algorithms have been successfully applied to more than 200 consulting projects in a wide range of applications: 1-cm to 10-m diameter, 10 to 1,500,000 RPM speed, internal & external rotor, axial and radial flux machines.

Fast

Set up your multiphysics simulation with a button click using predefined workflows.

Get calculation results within minutes using specific e-NVH models and algorithms.

Accurate

Use state-of-the-art calculation methods adapted to each design stage.

Include faults and tolerances for robust e-NVH ranking of electric machines.

Insightful

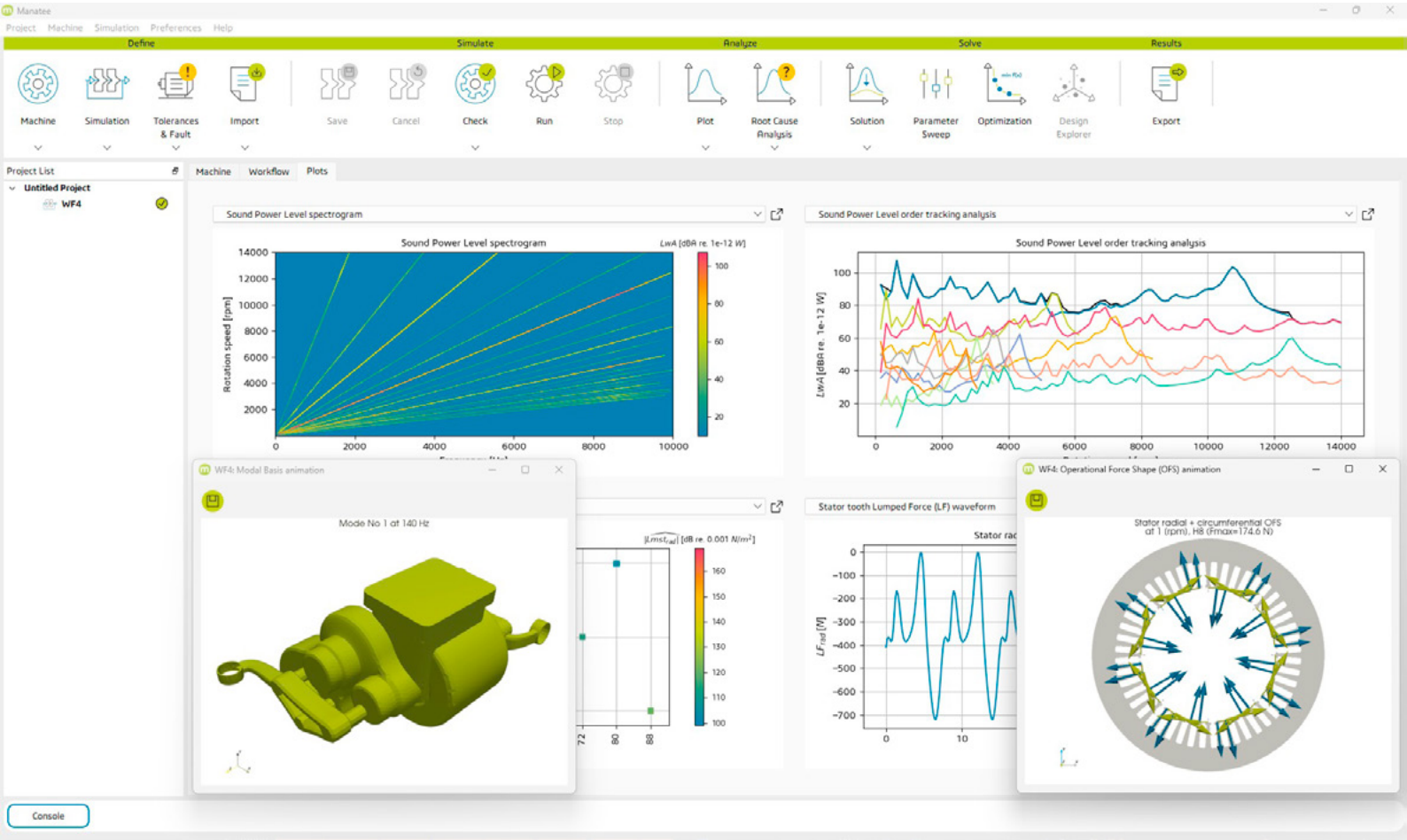
Understand the root cause of noise with advanced visualization tools.

Run “what if” scenarios, parameter sweeps and easily compare simulation results.

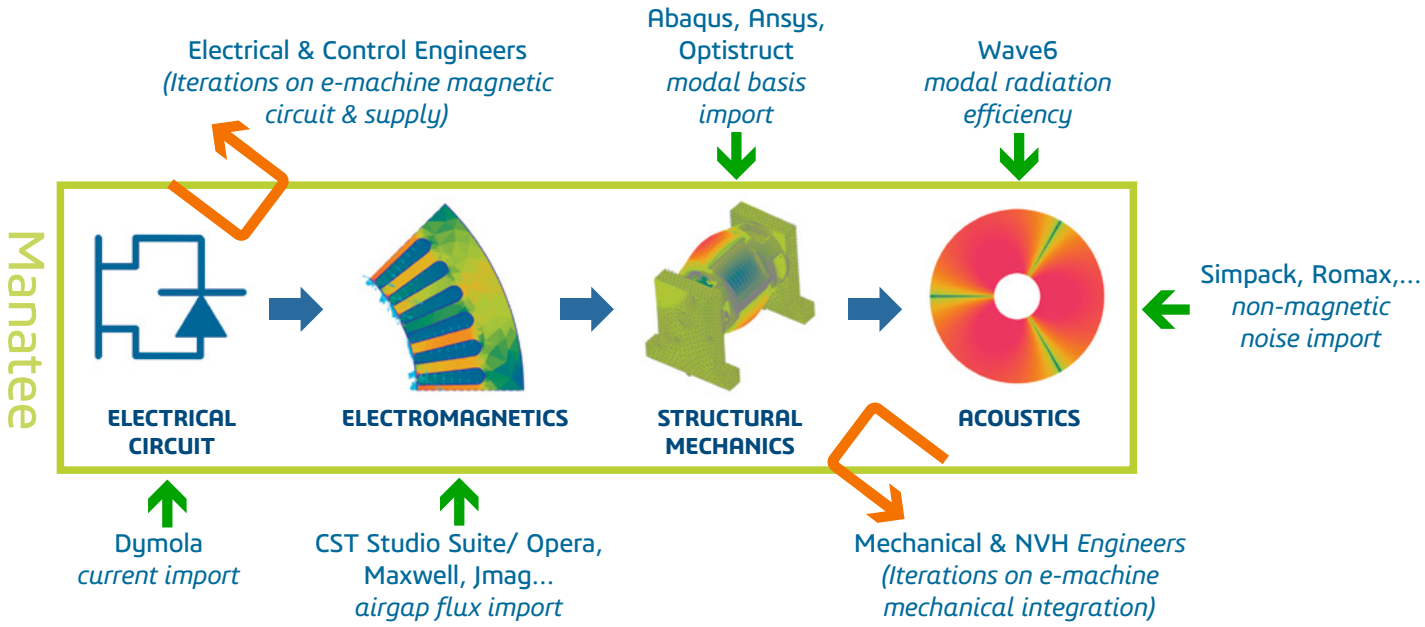
Collaborative

Explore the most relevant noise mitigation techniques on your electric machine.

Work in parallel with other engineering departments through a user-friendly GUI.



FEATURE INSIGHTS



Use **predefined simulation** templates adapted to every design stage and engineering field

Include fault & mechanical tolerances for a **robust vibro-acoustic design**

Find the **root cause** of noise and vibration in terms of structural modes and excitation forces

Choose and optimize the most adapted magnetic, control or mechanical **noise mitigation technique**

Run **offline Campbell diagrams** of magnetic forces to compare different e-machines

Run e-NVH calculations at **all speed and load levels**

Import a modal basis and analyze its response to **unit-wave Maxwell excitations** without running magnetic calculations

Combine structural calculations with operational loads using **electromagnetic vibration synthesis**

Separate the contribution of different magnetic orders with the automatic **order tracking** analysis

Analyze variable speed e-NVH effects with **spectrograms** and **listen** to your e-machine sound

Run **parameter sweeps** on electrical machine design parameters

Compare different simulation results and find the best electromagnetic and vibro-acoustic trade-offs

APPLICATION EXAMPLES

AUTOMOTIVE

During the electromagnetic design of an IPMSM traction motor for the electric powertrain, electrical engineers want to study the NVH impact of the skew pattern. This calculation is taking days in a general-purpose FEA software.

With Manatee, the effect of the rotor skew pattern on average torque, torque ripple and magnetic noise is quickly calculated on whole torque speed plane, providing clear guidance to **electromagnetic engineers**.

INDUSTRY

The end customer rejected the prototype of an industrial pump because it sounded louder than its competitor. The motor pump designer wants to improve the pump's sound signature.

Manatee helps to analyze test data, confirm the noise issue's magnetic origin, and set clear noise reduction targets using sound synthesis features. **Acoustic engineers** then study the effect of moving a natural frequency to meet the new targets.

ENERGY

A tonal noise issue is identified during factory acceptance tests of a wind turbine generator. Design engineers want to understand what is causing this sound and to reduce it.

Manatee simulation allows for identifying the modes and magnetic forces responsible for high tonality. **Control engineers** then run a simulation to confirm the efficiency of the harmonic current injection technique.

CONSUMER GOODS

A new manufacturing process for BLDC motor fans results in a higher eccentricity and uneven airgap. This may degrade sound quality, and engineers would like to estimate this without running NVH tests.

Manatee simulation is set up and run to estimate quickly the impact of asymmetries on acoustic noise due to electromagnetic excitations. This allows **mechanical engineers** to specify mechanical tolerances in line with NVH requirements.

NAVAL

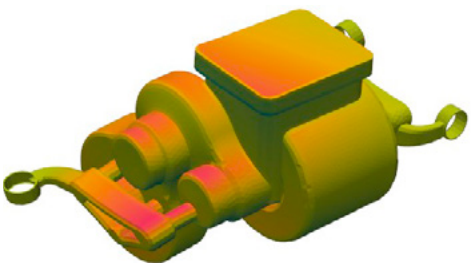
A new electric propulsion unit is designed to comply with Silent Class ship. Induction motor structure-borne noise must be evaluated, but magnetic force calculation requires time-consuming transient FEA simulation by **electrical engineers**.

The Manatee quick permeance/mmf model is used to calculate magnetic forces. The resulting structure-borne noise is obtained with a vibration synthesis algorithm. Compliance with standards is easily checked with third octave analysis.

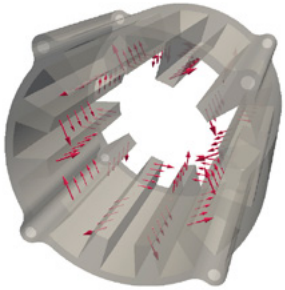
RAILWAY

An initial electrical design of a squirrel-cage induction motor is carried out for a light rail vehicle application. The sound power level has to fulfill IEC 60034 noise limits at variable speed, which requires a massive number of multiphysics calculations.

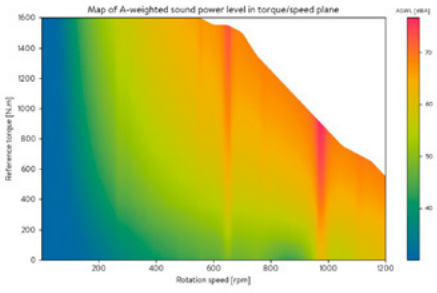
Electrical and mechanical engineers quickly perform e-NVH calculations under Manatee, showing the presence of a large slotting resonance. A parameter sweep on the rotor slot number achieves 15 dB noise reduction with the same torque level.



Operating Deflection Shape computed in Manatee



Magnetic tooth forces computed in Manatee



A-weighted Sound Power Level on full torque/speed plane calculated with Manatee

3DEXPERIENCE®

Dassault Systèmes is a catalyst for human progress. Since 1981, the company has pioneered virtual worlds to improve real life for consumers, patients and citizens.

With Dassault Systèmes' **3DEXPERIENCE** platform, 370,000 customers of all sizes, in all industries, can collaborate, imagine and create sustainable innovations that drive meaningful impact.

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