Manatee® V2 software services

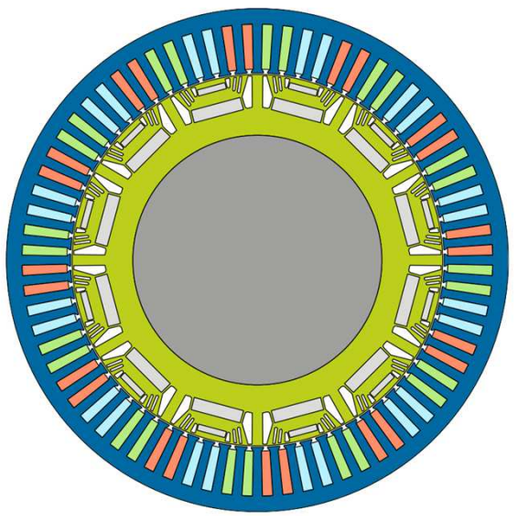
Improving e-NVH performances of electrical systems throughout their development lifecycle

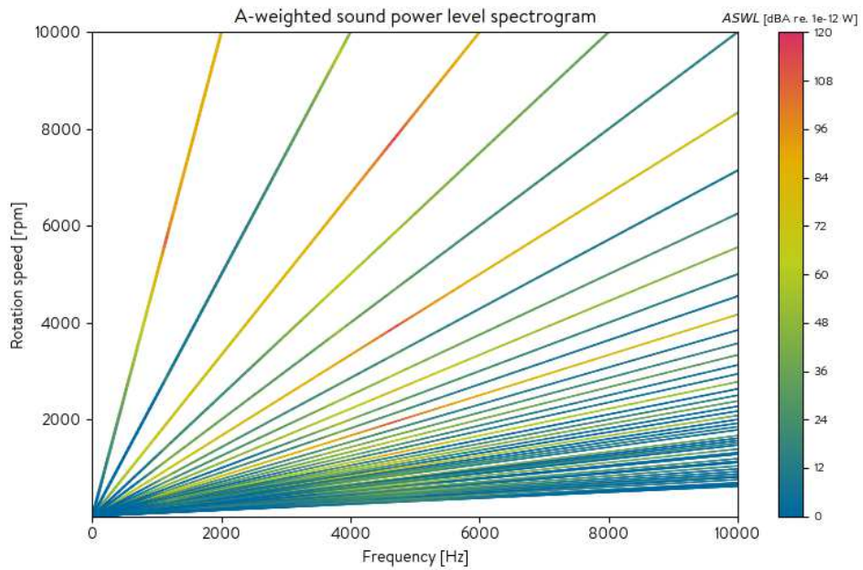
Jean Le Besnerais
Anne Trummer

© 2013-2021 EOMYS ENGINEERING / www.manatee-software.com / www.eomys.com

SOFTWARE SERVICES

From e-machine geometry & control parameters…



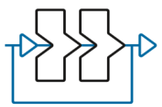


… to system-level electromagnetic noise and vibration

© 2013-2021 EOMYS ENGINEERING / www.manatee-software.com / www.eomys.com

Manatee is a pioneering software,

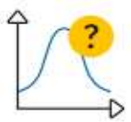
Manatee is the **only software specialized** on the **electromagnetic design optimization of electrical machines,** including **magnetic vibrations and acoustic noise** due to Maxwell forces (“e-NVH”).



Predefined simulation workflows from basic to detailed design phases

Fast and accurate calculations adapted to each engineering field

Robust design based on faults and tolerance simulation



Root cause analysis using powerful post-processing

Mitigation techniques with specialized design environments

© 2013-2021 EOMYS ENGINEERING / www.manatee-software.com / www.eomys.com

Inspired by a wide consulting experience,

- Up **40 dB acoustic noise reduction** after redesign based on EOMYS consulting activities
- e-NVH models successfully applied on more than **170 industrial cases**
- Wide range of topologies (IPMSM, SCIM, WRSM, DFIG, inner & outer rotor)
- Wide range of applications (from W to MW range, from 5 rpm to 150 000 rpm, from 10mm to 10m diameter)

STELLANTIS GOLDWIND Nidec dyson alconza Irizar Group ALSTOM

© 2013-2021 EOMYS ENGINEERING / www.manatee-software.com / www.eomys.com

Reducing development time of electrical systems,

Fast simulation set-up of multiphysic model couplings,
quick calculations including **predefined post-processing**

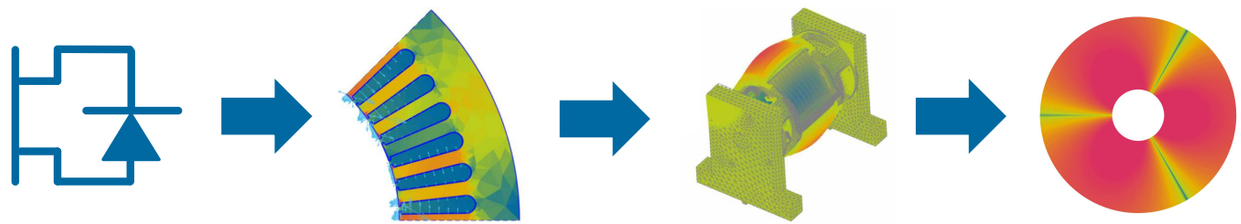
Accurate variable-speed vibroacoustic assessment
based on proprietary algorithms specialized on e-NVH

Simultaneous collaboration of different engineering fields
during whole development cycle

Insightful visualization and troubleshooting tools to quickly
implement the most relevant noise control actions

© 2013-2021 EOMYS ENGINEERING / www.manatee-software.com / www.eomys.com

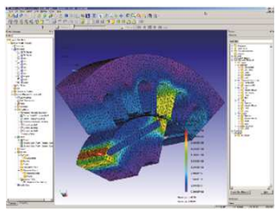
Integrating ready-to-use multiphysic models,



- **Predefined coupling** between physics
- Implementation of different **speed Vs accuracy** tradeoffs adapted to every design stage
- **Automatic parametrization** to improve accuracy and speed-up calculation

© 2013-2021 EOMYS ENGINEERING / www.manatee-software.com / www.eomys.com

Interfacing with existing CAE tools,



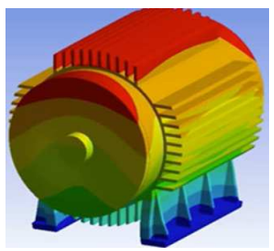
.csv

Third-party electromagnetic design tools

Third-party NVH data acquisition tools

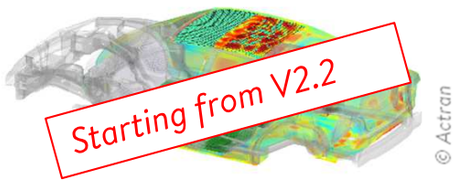
manatee by EOMYS

Standalone e-NVH virtual prototyping solution



.unv

Third-party structural design tools



Third-party acoustic design tools

© 2013-2021 EOMYS ENGINEERING / www.manatee-software.com / www.eomys.com

Through a user-friendly simulation and analysis GUI.

© 2013-2021 EOMYS ENGINEERING / www.manatee-software.com / www.eomys.com

LICENSING & DEVELOPMENT ROADMAP

© 2013-2021 EOMYS ENGINEERING / www.manatee-software.com / www.eomys.com

Leasing licenses - overview

Our short-term to long-term **leasing solutions** include:

- all release updates (at least 4 per year)
- all available features at release time
- IT support
- **e-NVH support** package with our e-NVH experts

All licensing solutions require a **technical training:**

- e-NVH basics (optional, can be avoided if Customer already attended EOMYS e-NVH training)
- Manatee software (mandatory, can be applied to Customer case as an option)

© 2013-2021 EOMYS ENGINEERING / www.manatee-software.com / www.eomys.com

Leasing licenses - e-NVH support

- "e-NVH support" provided with all Manatee **leasing solutions**
- Carried by our e-NVH engineers or software engineers, as a package of engineering hours

e-NVH support as consulting

- Simulation advices
- Result interpretation
- Test & simulation fitting
- Problem solving

e-NVH support as training

- Training on Manatee software
- Training on a particular topic (e.g. effect of uneven airgap on magnetic forces)

e-NVH support as scripting

- Accelerated release of some specific features
- Customized developments

© 2013-2021 EOMYS ENGINEERING / www.manatee-software.com / www.eomys.com

Summary of license types

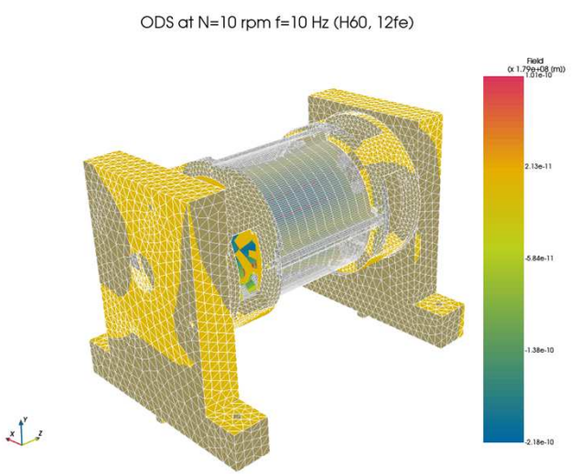
	Leasing	Perpetual – full	Perpetual – partial
Features	all	all	selection through optional features
Releases	all	all*	all*
IT support	yes	yes*	yes*
e-NVH support	yes	no	no
Maintenance fee	no	yes	yes
Customized feature development	Within a consulting project (cost deduced from 3-yr leasing license) and/or using e-NVH support hours	Within a consulting project (cost deduced from perpetual license)	no

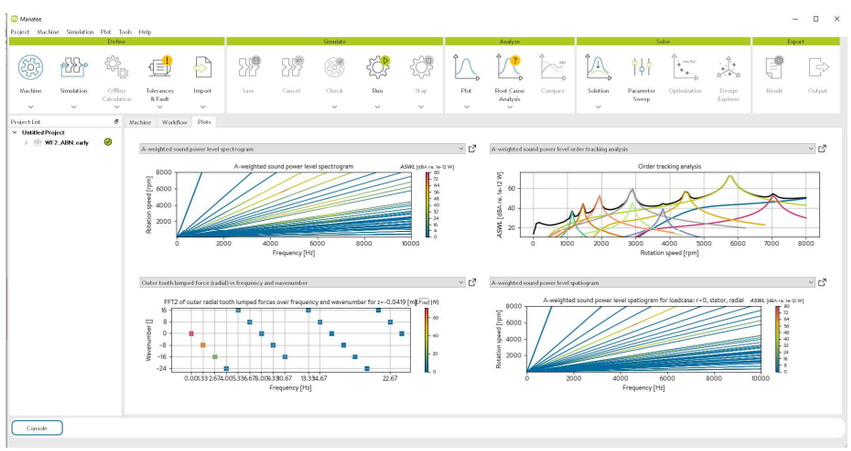
**provided that maintenance fee has been paid*

© 2013-2021 EOMYS ENGINEERING / www.manatee-software.com / www.eomys.com

Manatee « consulting demo »

- **Free trial version** of Manatee is restricted to default machine library
- Alternative option : commercial consulting project including a demonstration of Manatee software applied to Customer case
- "**Manatee consulting demo**" deliverables:
  - simulation & e-machine files to be able to reproduce simulation results obtained by EOMYS
  - 1h live demo of Manatee demonstrating how simulation has been run and interpretations





© 2013-2021 EOMYS ENGINEERING / www.manatee-software.com / www.eomys.com

Manatee V2 release plan - overview

Electrical engineers
= V2.0 March 2021

Electrical engineers
+Mechanical engineers
= V2.1 June 2021

Electrical engineers
+Mechanical engineers
+Acoustic engineers
= V2.2

Electrical engineers
+Mechanical engineers
+Acoustic engineers
+NVH test engineers
= V2.3

- **"Key features"** according to development roadmap + "Sprint features"
- Manatee V2 is developed according **Agile methodology** with continuous production
- Regular releases (code optimization, GUI improvement, sprint features) every 3 months
- Sprint feature development prioritized according to customer feedback
- High reactivity (2-week patch)
- Continuous development of tutorial on Manatee website

© 2013-2021 EOMYS ENGINEERING / www.manatee-software.com / www.eomys.com

Manatee technical requirements

- **Windows 8/10 64-bit architecture** (includes **multi-core parallelization at no extra cost**)
- For cloud-based licenses (Single Computer or Floating):

  - **internet connection**
- For server-based licenses (Floating only):

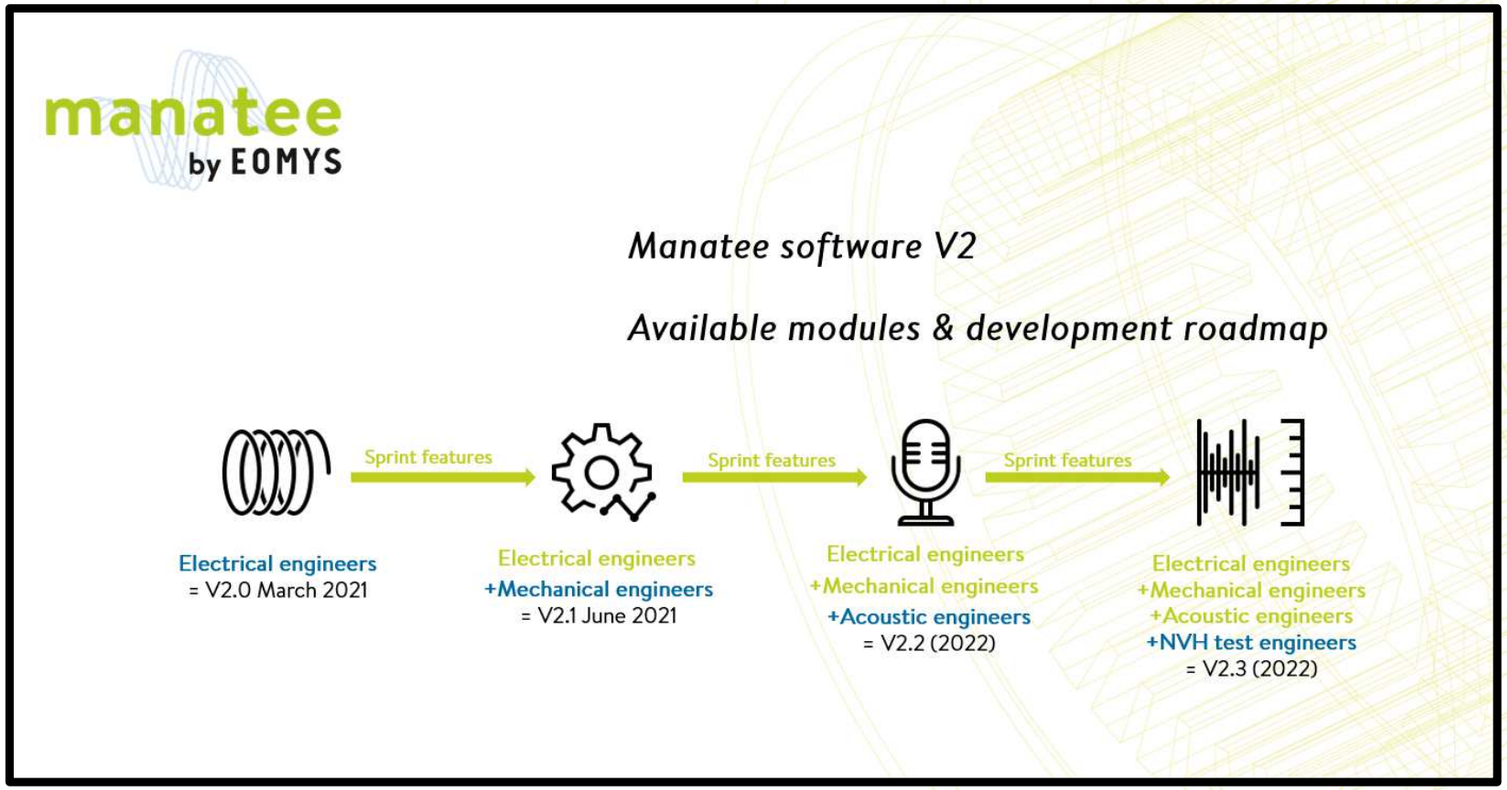
  - **administration rights** to start Manatee Server which runs as a service on Windows

  - host computer for Manatee Server and host computer for Manatee connected on same local network

  - no internet connection required
- 16 Go RAM & 10 Go disk space recommended
- FEMM 4.2 pre-installation when running electromagnetic simulations

© 2013-2021 EOMYS ENGINEERING / www.manatee-software.com / www.eomys.com

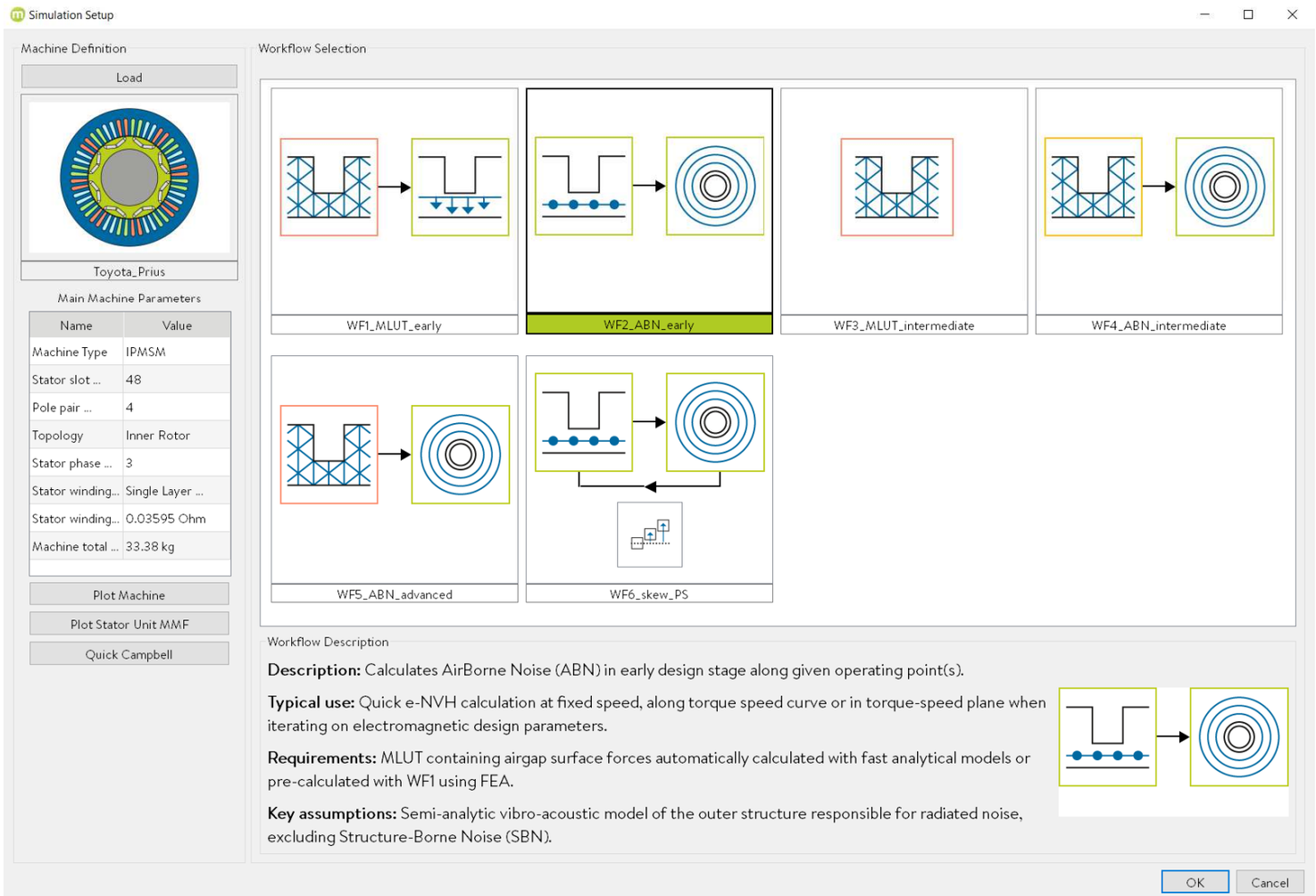
DETAILED FEATURES



See "Manatee V2 modules and development roadmap" PPT for more details

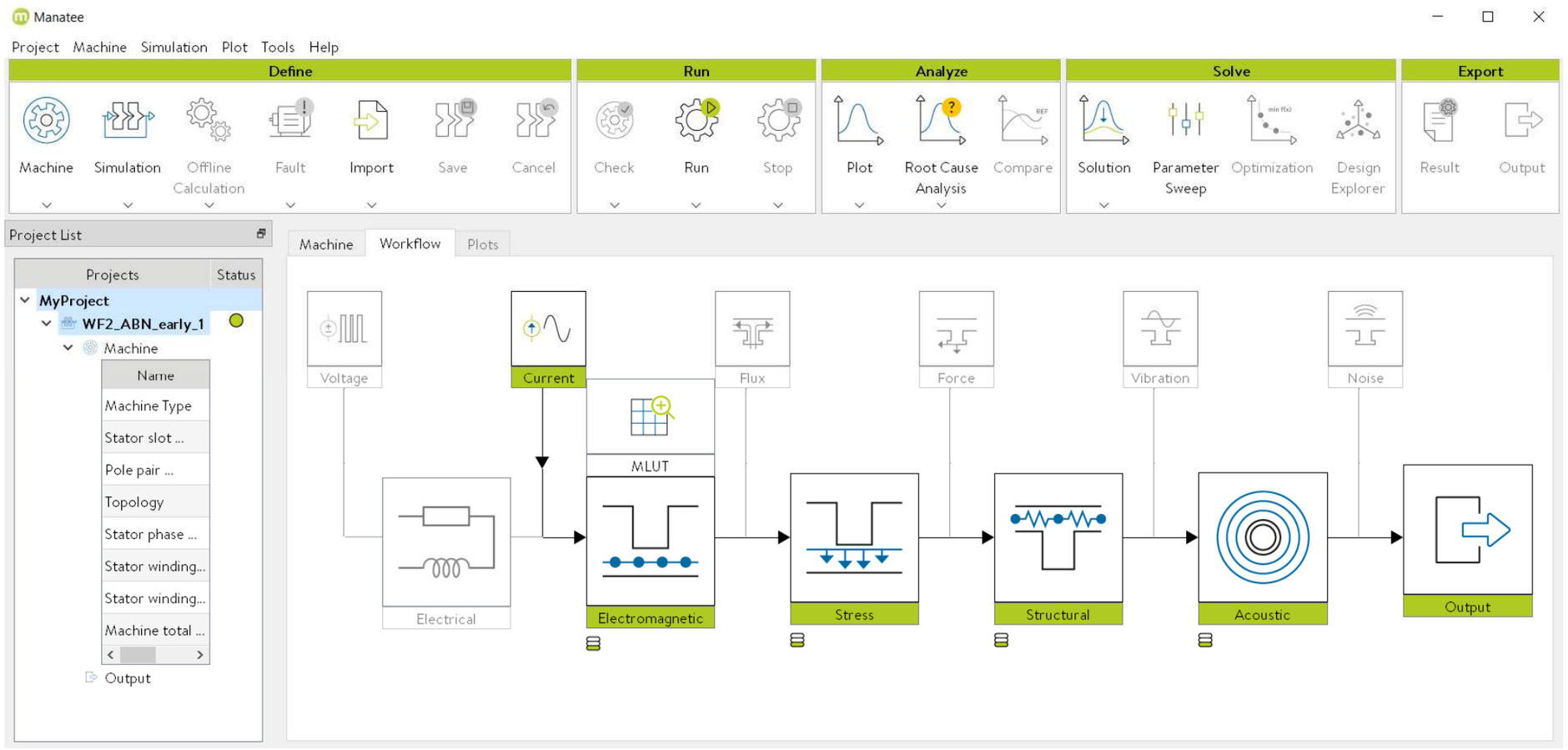
© 2013-2021 EOMYS ENGINEERING / www.manatee-software.com / www.eomys.com

e-NVH predefined workflows



© 2013-2021 EOMYS ENGINEERING / www.manatee-software.com / www.eomys.com

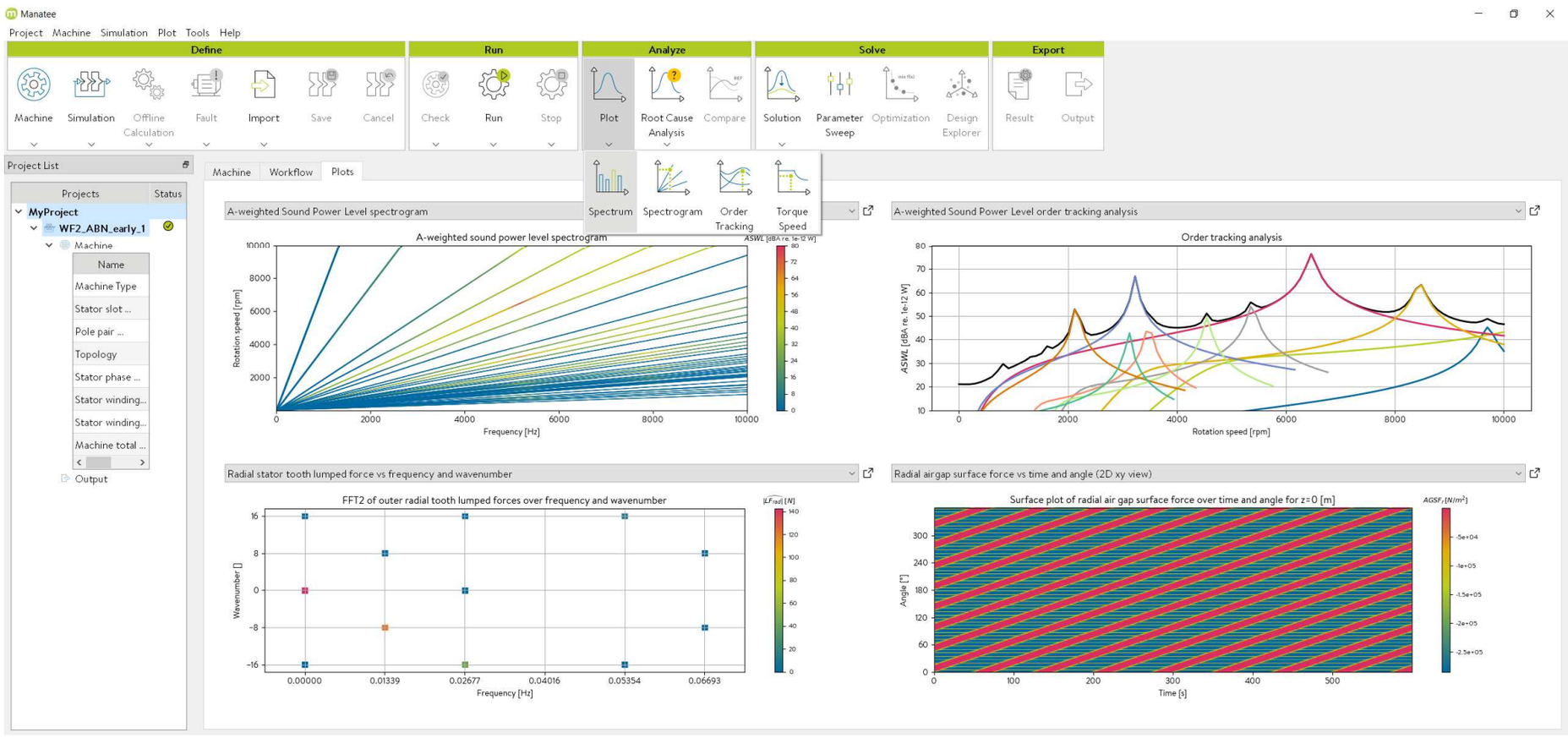
e-NVH predefined workflows



[Feature tutorial video]

© 2013-2021 EOMYS ENGINEERING / www.manatee-software.com / www.eomys.com

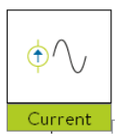
e-NVH predefined graphical post processing

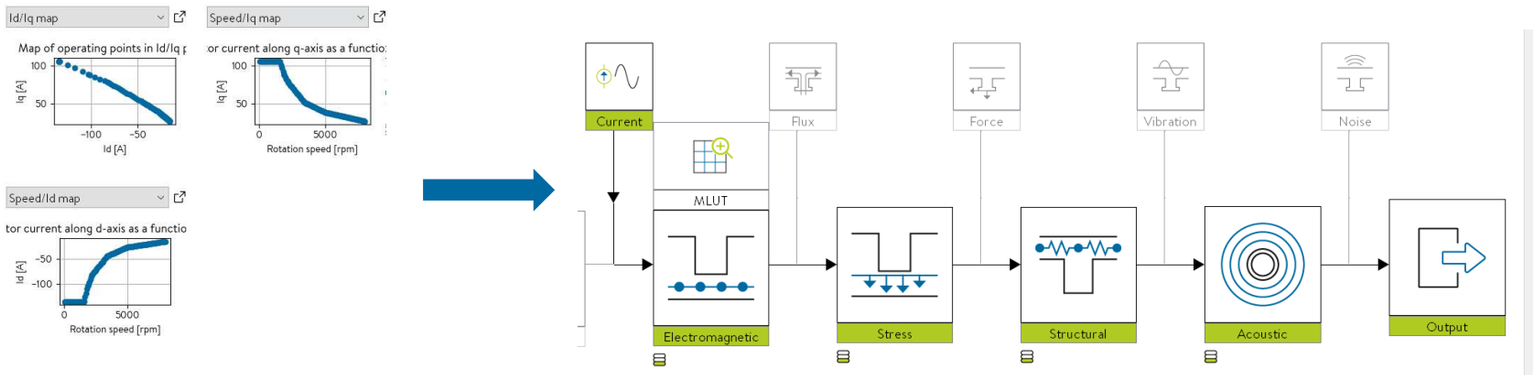


© 2013-2021 EOMYS ENGINEERING / www.manatee-software.com / www.eomys.com

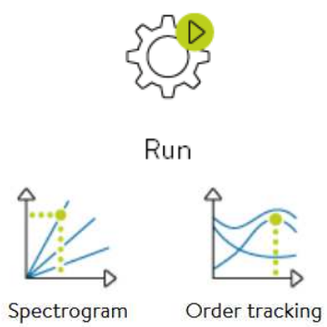
e-NVH calculation along max torque speed curve

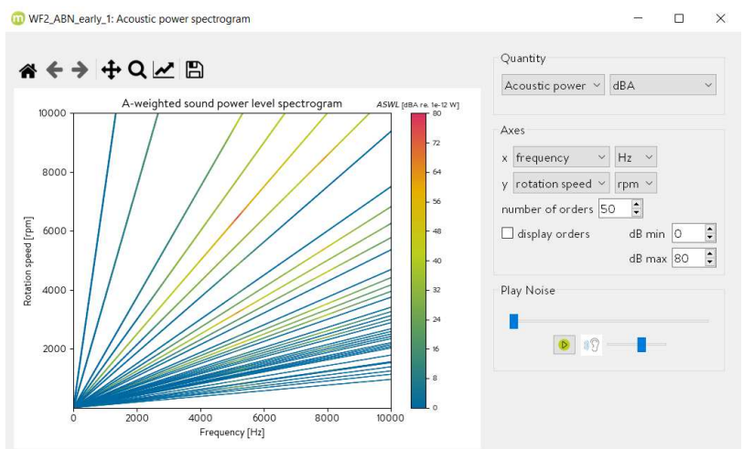
1. Define variable speed current control law

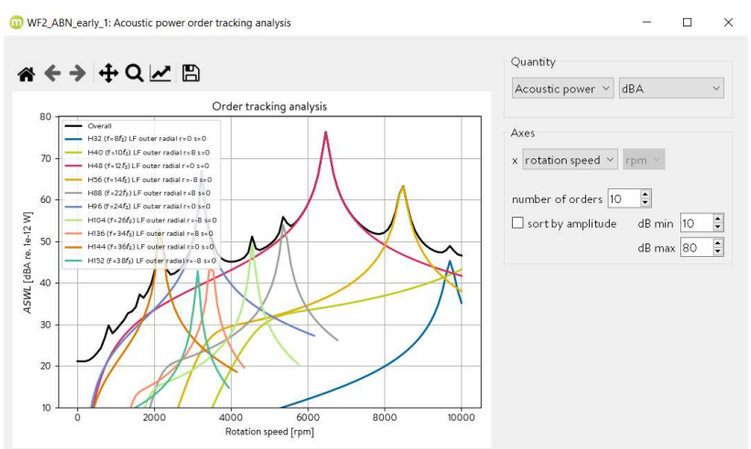




2. Run & plot



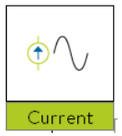


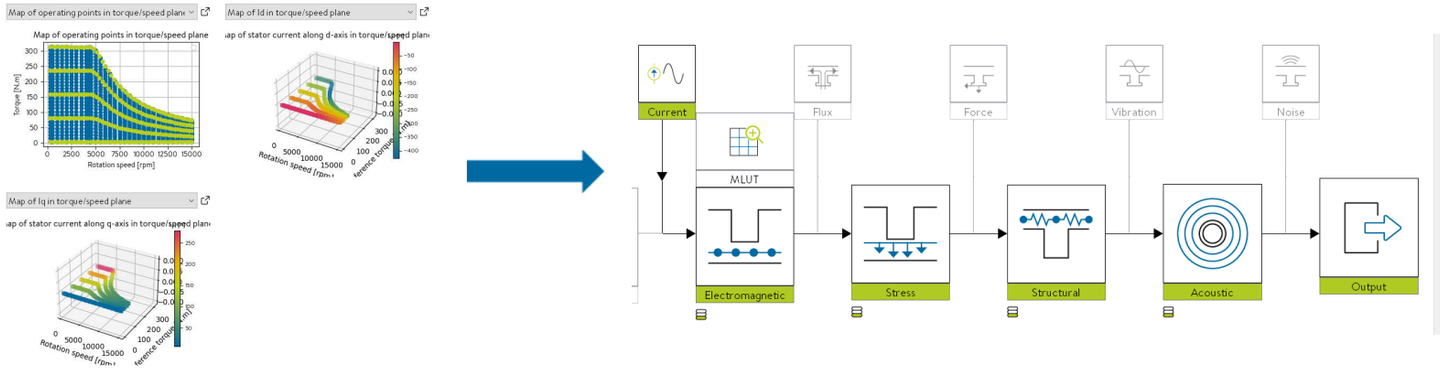


© 2013-2021 EOMYS ENGINEERING / www.manatee-software.com / www.eomys.com

e-NVH calculation on whole torque-speed plane

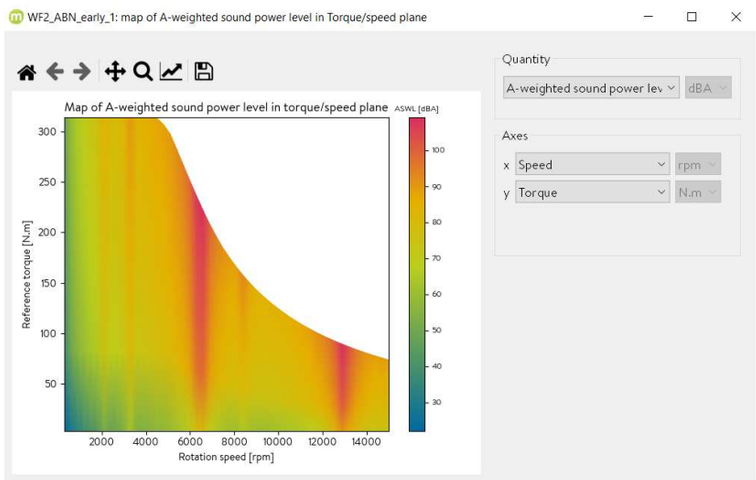
1. Define variable speed current control law





2. Run & plot

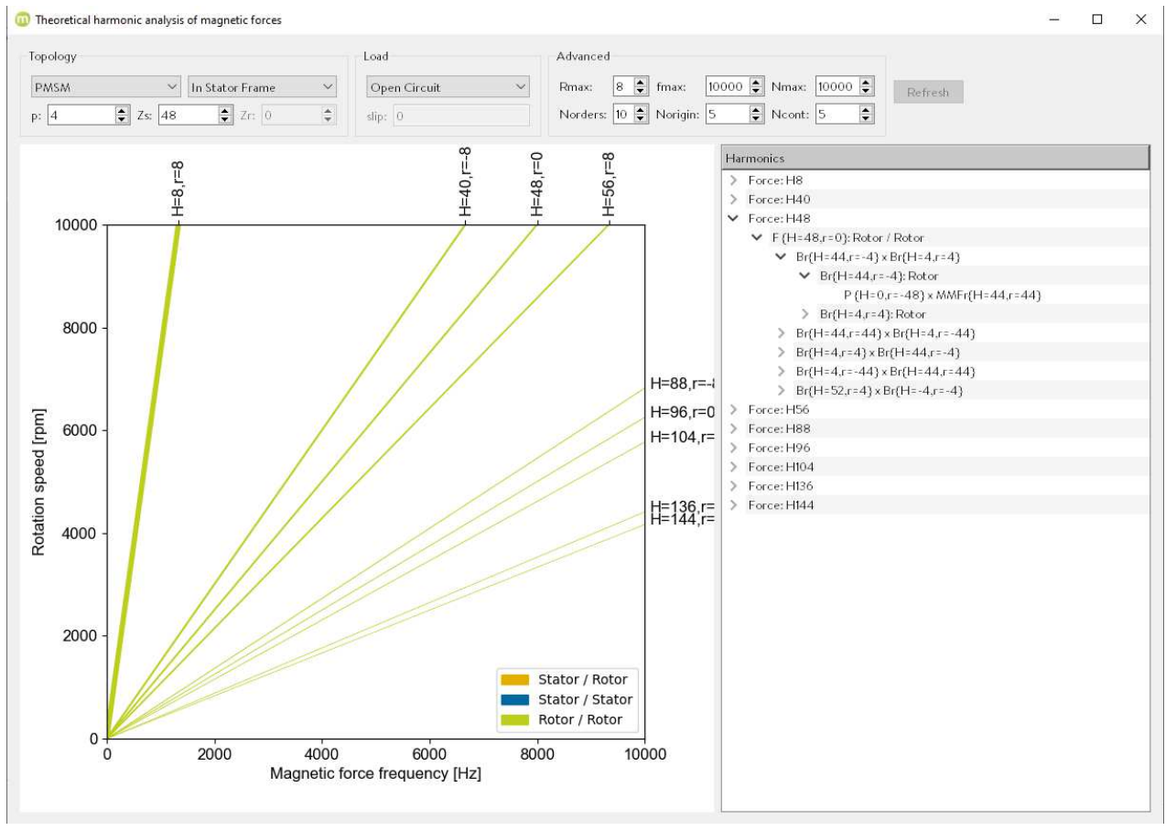
Run



© 2013-2021 EOMYS ENGINEERING / www.manatee-software.com / www.eomys.com

e-NVH root-cause analysis with Campbell diagrams

- Automated **offline Campbell diagram** based on load state, topology and slot/pole combination:

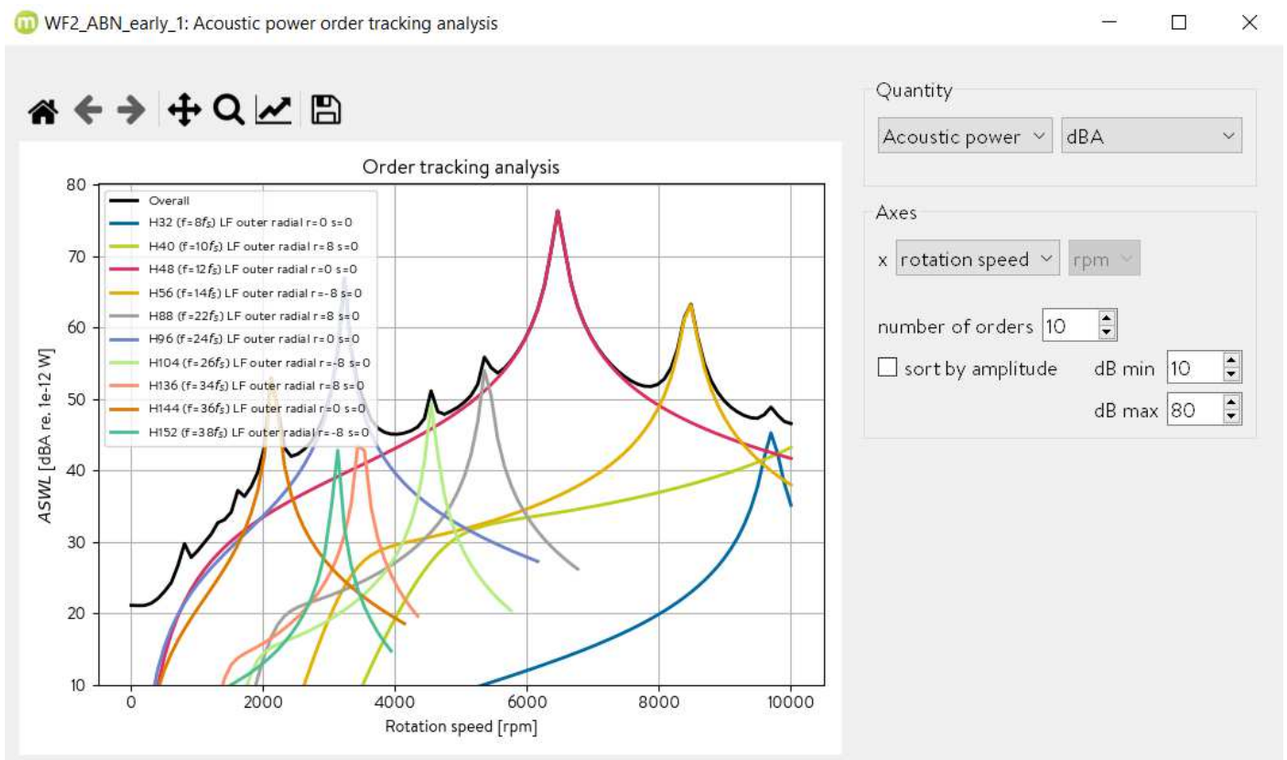


© 2013-2021 EOMYS ENGINEERING / www.manatee-software.com / www.eomys.com

e-NVH root-cause analysis with advanced plots

Manatee includes predefined **root cause analysis post processing:**

- **Order Tracking** based on **automated identification of main force wavenumbers**

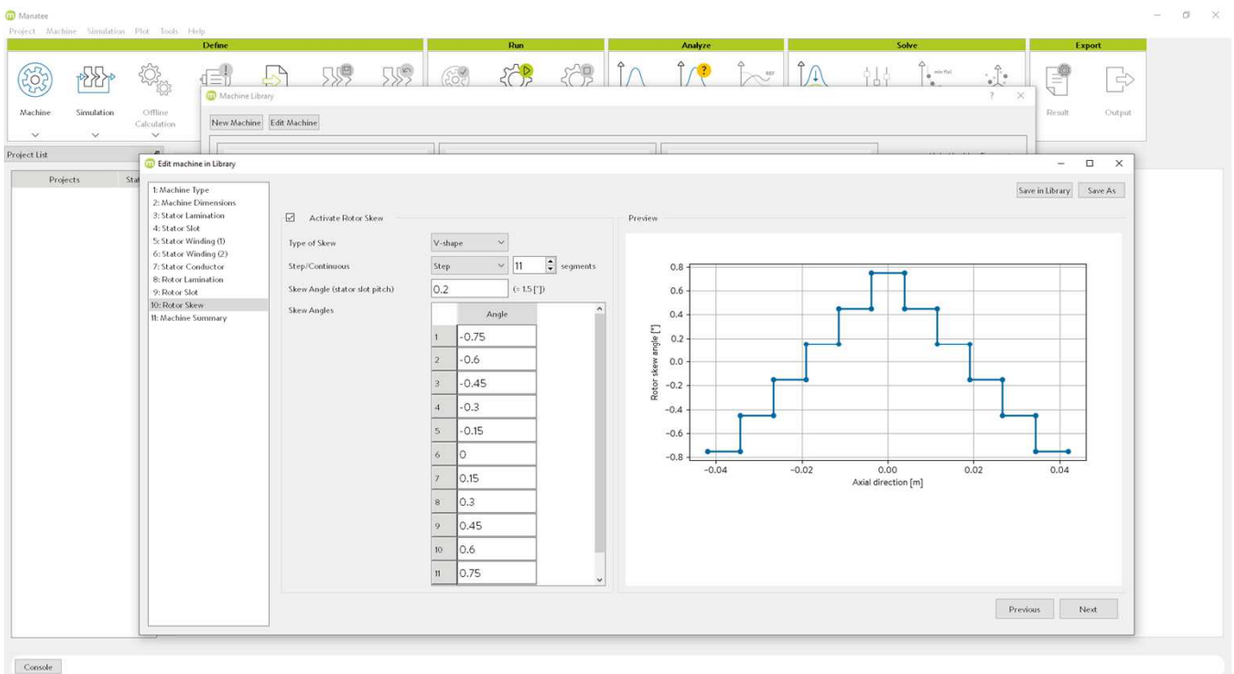


© 2013-2021 EOMYS ENGINEERING / www.manatee-software.com / www.eomys.com

e-NVH mitigation with rotor skew

Manatee includes built-in design environment of **skewing technique**

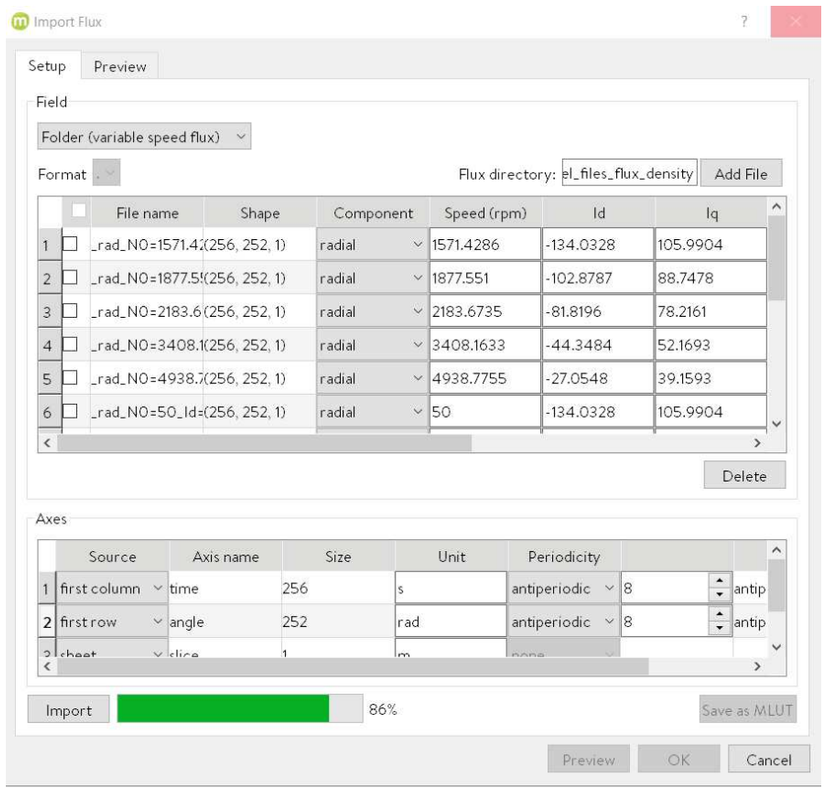
- Possibility to define any rotor skew shape
- Automated **parameter sweep** of NVH & torque ripple function of **skew** angle

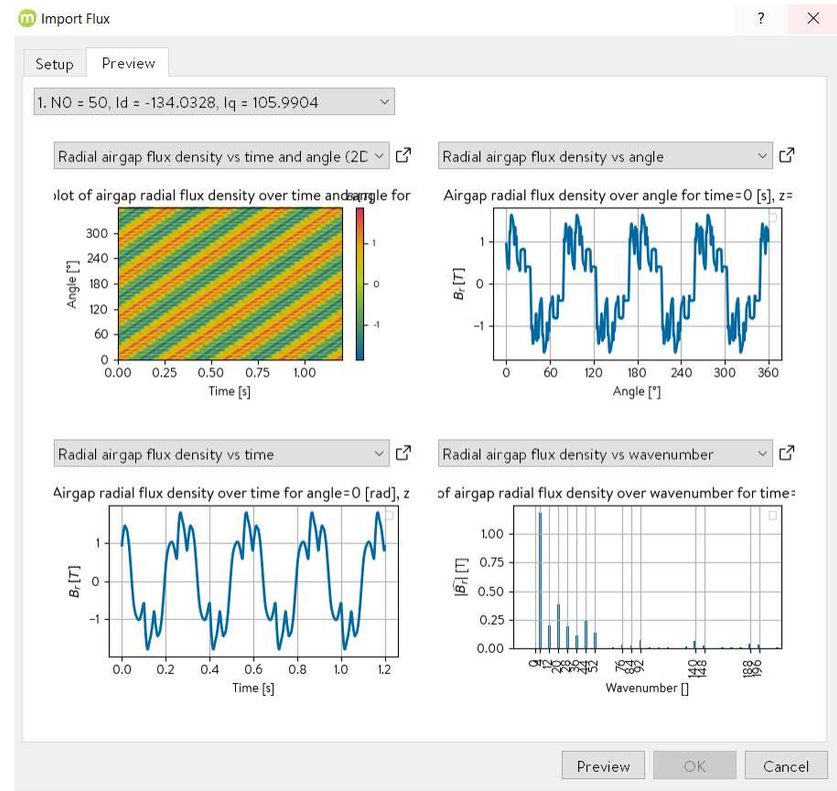


© 2013-2021 EOMYS ENGINEERING / www.manatee-software.com / www.eomys.com

Import of flux density distribution

- Import of **third party flux density** distribution (fixed speed, variable speed, multi slice) in Excel format



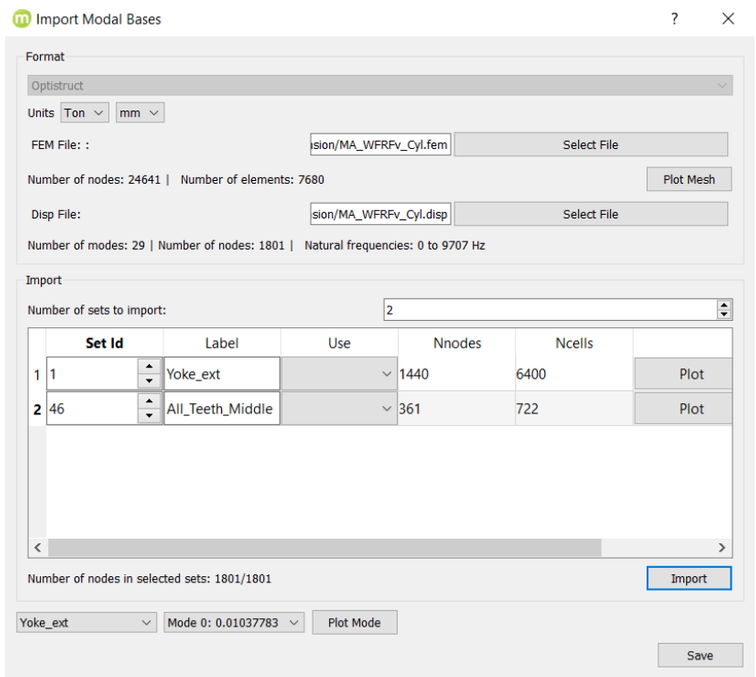


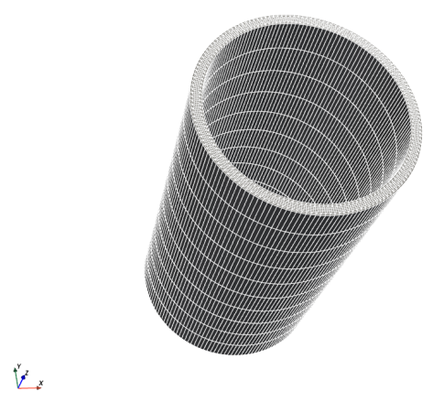
Feature tutorial video in progress

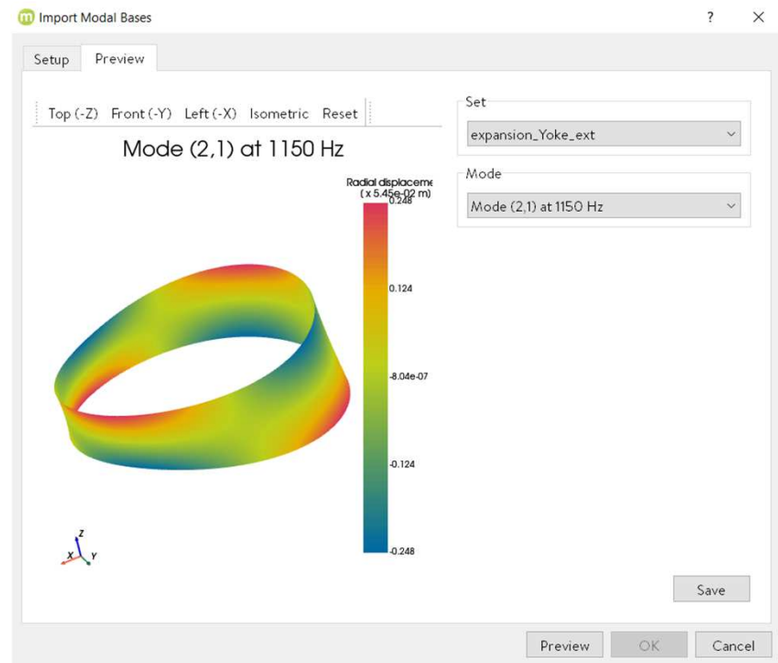
© 2013-2021 EOMYS ENGINEERING / www.manatee-software.com / www.eomys.com

Import of modal basis

- Import of third party modal basis on a structural mesh in different formats: .unv(o), .disp + .fem (Optistruct), .txt + .mesh (Ansys), .OP3 etc.







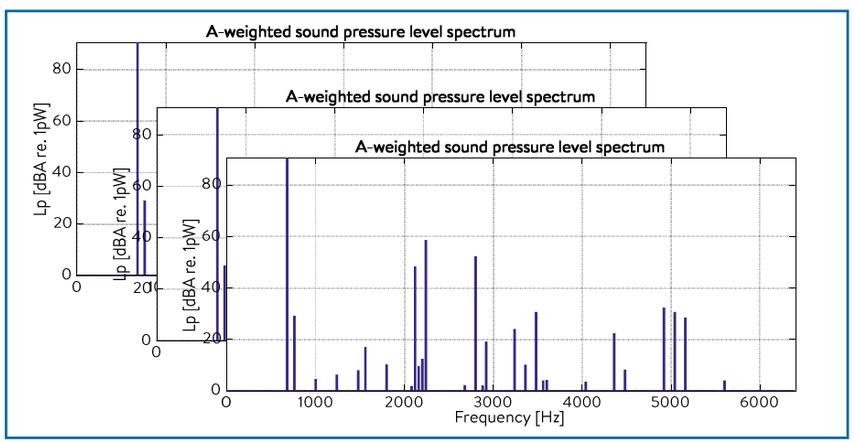
Feature tutorial video in progress

© 2013-2021 EOMYS ENGINEERING / www.manatee-software.com / www.eomys.com

Load Extrapolation Algorithm

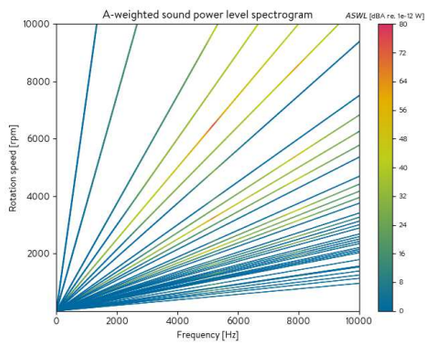
Manatee can speed-up magnetic load calculations in early design phase:

- **Load Extrapolation Algorithm (LEA) extrapolates loads at all speeds based on 1 to 6 single calculations** (saturation of reference operating point is assumed constant over speed)
- **LEA reduces numerical parasitic noise**

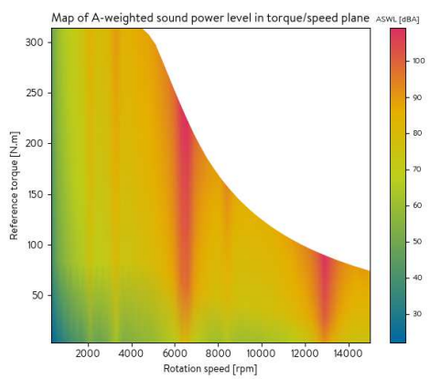


Single/several speed calculations

≈ 10 s



≈ 1 min

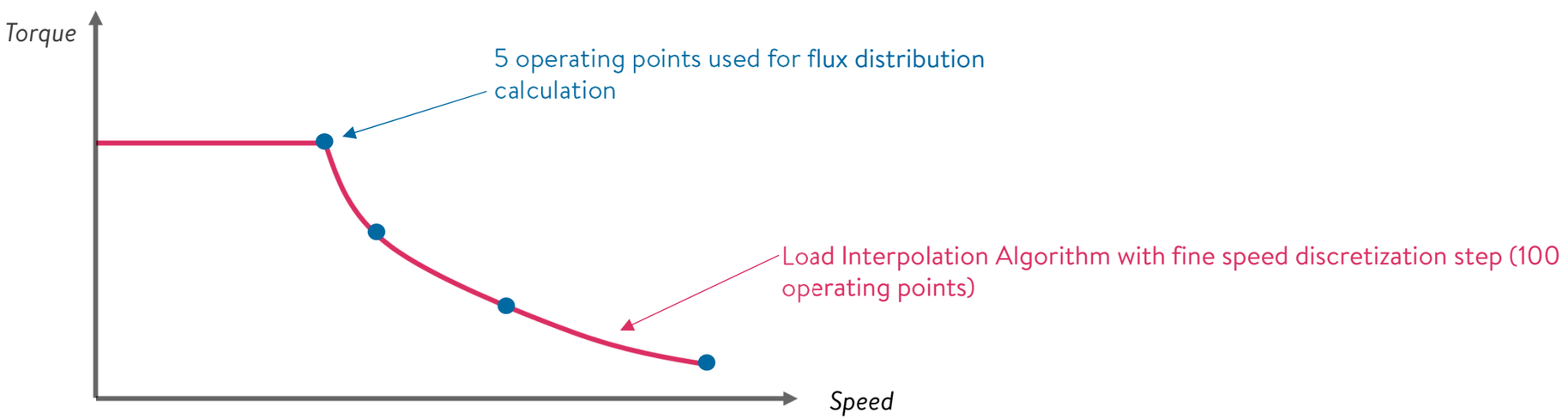


© 2013-2021 EOMYS ENGINEERING / www.manatee-software.com / www.eomys.com

Load Interpolation Algorithm

Manatee can speed-up magnetic load calculations in detailed design phase:

- **Load Interpolation Algorithm (LIA)** interpolates **flux distribution at variable speed** from specific points along torque/speed curve
- LIA can also interpolate PMSM **flux distribution function of Id/Iq** to more quickly calculate magnetic loads under **skewing** or e-NVH in four quadrant operation
- Flux interpolation is **more robust to numerical issues** compared to force interpolation



© 2013-2021 EOMYS ENGINEERING / www.manatee-software.com / www.eomys.com

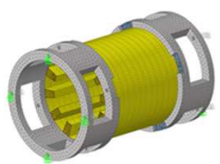
Electromagnetic Vibration Synthesis

- Faster than direct vibration calculation at variable speed/torque, with more physical insights

Unit magnitude magnetic load vector harmonics (r=0, ±1, ±2 ...) radial + tangential + moments applied to stator + rotor

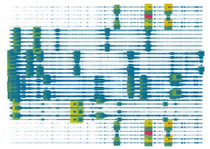
STRUCTURAL CHARACTERIZATION

STRUCTURAL MODEL



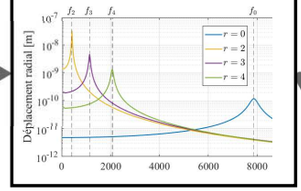
Modal force projection

UNIT MODAL FORCE MATRIX



Modal expansion

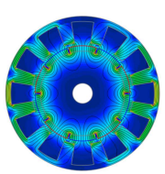
VIBRATION FRF



3D external FEA software (rotor+stator) or Manatee stator structural models

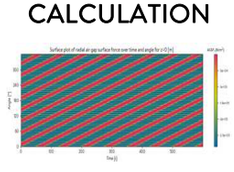
CALCULATION OF OPERATIONAL LOADS

MAGNETIC MODEL

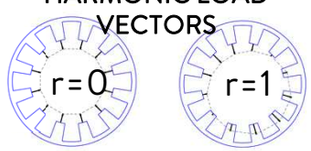


Magnetic flux distribution

MAGNETIC FORCE CALCULATION



HARMONIC LOAD VECTORS



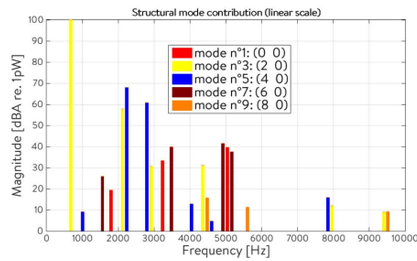
+ r=...

2D or 2.5D external FEA software or Manatee magnetic models

manatee by EOMYS

ELECTROMAGNETIC VIBRATION SYNTHESIS

AIR-BORNE NOISE



Stator Load Case contribution
Structural mode contribution
Noise induced by stator torque ripple & UMP

STRUCTURE-BORNE NOISE

Rotor Load Case contribution
Structural mode contribution
Noise induced by rotor torque ripple & UMP

© 2013-2021 EOMYS ENGINEERING / www.manatee-software.com / www.eomys.com

CONCLUSION

© 2013-2021 EOMYS ENGINEERING / www.manatee-software.com / www.eomys.com

Manatee software

- **Pioneering software** specialized in the assessment of magnetic forces, vibrations and acoustic noise
- Only simulation & analysis environment combining **e-NVH troubleshooting and mitigation tools**
- Designed to ease **electrical, mechanical, acoustic, NVH test engineers** collaboration throughout electrical system development in a **modern, user-friendly GUI**
- Developed based on a extensive consulting experience of e-NVH (> 150 e-machines analyzed) and R&D

manatee by EOMYS

© 2013-2021 EOMYS ENGINEERING / www.manatee-software.com / www.eomys.com

Contact details

Commercial inquiries

Anne Trummer

anne.trummer@eomys.com

+33(0) 7 62 41 59 12

Technical questions

Emile Devillers

emile.devillers@eomys.com

+33(0) 9 81 36 60 46

To stay up to date and receive all the latest information about Manatee (webinars included):

- Follow us on LinkedIn at http://www.linkedin.com/company/eomys
- Subscribe to our newsletter at https://eomys.com/news/newsletter/

© 2013-2021 EOMYS ENGINEERING / www.manatee-software.com / www.eomys.com