SEA+ version info

Version 2.01

- Add frequencies range change
- Bug fix in "recent files" menu - the not found file is erased from menu
- Bug fix in the edition of the section of material

Version 2007.2

- Opengl selection improvement
- Opengl translation improvement
- Add opengl icon for sea object
- Bug fix geometry import (CNES data)
- Bug fix spectrum import (spectrum name with underscore)
- Bug fix modal density selection in the property window of virtual subsystems
- Bug fix in data import (negative values interpolation of spectrum)
- Add draw power flow
- Add some opengl options
- Bug fix in wavenumber calculation
- Bug fix in virtual subsystem section selection (property page)

Version 2007.2.1

- Bug fix in solver (bad resolution when subsystems are erased) - Seaclass.dll
- Bug fix in Edit Spectrum window (the std. err. component is updated) - DataBaseClass.dll

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Version 2008.1

- Development under net framework 2.
- Add fluid loading option on structure (calculation of the radiation efficiency)
- Improvement of calculations of CLF junction between cavity and Virtual subsystem
- Frequency band is adapted to SEAVirt imported data (not implicitly in 3rd Oct.)
- Improvements of the interface
- Minor bugs fixed

Version 2008.1.1

- Bug fix: first frequency band is not imported correctly from SEAVirt data
- Change hasp key with license file (floating or node-locked license)

Version 2009.1

- Ability to create new SEA model
- New mathlib of SEA subsystems & CLF
- Three wave components for each structural SEA object (modal density & wavenumber)
- New wave transmission engine for CLF (Three wave type & joint)
- New SEA elements (sandwich, singly & doubly-curved shell, rib stiffened SEA subsystems)
- New module: shock response prediction with "SEA-Shock" optional module

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Version 2009.2

- Corrections
        mode computation (multilayer ribbed subsystem)
        SEA solver when 2 subsystems are link with multiple junctions
- Add power loss - input (3 waves)

Version 2009.2.1

- Minor bugs fixed

Version 2010

- New SEA Source added: turbulent boundary layer excitation

Version 2011

New module: SEA-Foam prediction with "SEA-Foam" optional module
   – New material type: Fiber, Septum, Foam, Perforated Material, Perfect fluid, Trimlayer (edition and creation of trims)
   – Added mass and added damping from trim when applied to subsystem
   – Trim TL and Trim absorption
   – Generation of acoustic fluid from perfect fluid
Subsystems
   – Fixed wavenumber and modal density calculation of ribbed stiffness shells and plates
   – New laminate section property and laminate ribbed
   – Importing Laminate section from NASTRAN
   – Creation of equivalent orthotropic material from Laminate
Junctions
   – Acoustic radiation
      o Modification of radiation efficiency prediction for curved shells: radiation kernel based on infinite helicoidal wave
      o Modification of radiation efficiency prediction for ribbed plate and curved shells: radiation as weighted averaged of 4 shell mode types radiation

- Mechanical coupling
  - o Modification of joint impedance formulation: improve solution for vibratory insulation
- Adding serial transfer function in junction parameter

User_interface
- Global control of subsystems and junctions size
- Global management of transparency of network objects
- Model Background color is now user-defined

Database
- New database engine: SQLite (more performance, model size up to 1 Tb
- New binary format for models: .dbsv3
- Utility provided to convert older models dbsv2 to dbsv3
- Import Nastran data: Mat(1,2,8) and pcomp

Platform support
- WinXP 32 & 64 bits
- Vista
- Seven 32 & 64 bits
- Win2k no more supported

Version 2012

New Solver
- Introduction constraint equations in the solver
  - o Loss matrix now symmetric with accelerated math lib

New element
- Active Sound Probe (ASP)
  - o Direct injection of diffuse, semi-diffuse and incident acoustic power in structural and subsystems
- Infinite Fluid Volume (IFV)
  - o Collect power radiated from subsystems through FFT connectors.

New connector
- Constraint connector
  - o Allow to impose transfer function between two subsystems such as equipartition of modal energy
- Free Field Transfer (FFT) connector
  - o Connect an ASP to a source: allow calculating ASP pressure at a distance from a source using built-in law with decreasing pressure with distance or user-defined transfer function
- Local Power Connector (LPC)
  - o Connect an ASP to a subsystem: allow calculating input power from ASP in the subsystem

Laminate Damping Loss Factor
- Laminate with viscous layer
  - o Now equivalent DLF of the laminate shell is taken into account shear dissipated energy improving DLF simulation for sandwich with thin layer insertion of viscoelastic material

User_interface
- Duplicate analytical subsystems
- Create new model with Nastran geometry
- Read Nastran PSHELL

Junctions
- Acoustic radiation of unbaffled plates
- Low frequency correction of numerical radiation efficiency for baffled plates

- Documentation is split in two parts: SEA+ User's Guide and SEA+ Advanced Theory

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Version 2012.0.4

New element
- Power Sound Filter (PSF)
  - o Inserting trim and leaks within an acoustic source and an ASP from subsystems through FFT connectors

New connector
- Constraint connector
  - o GEC constraint connector (modification of the behavior of previous constraint connector)
- Free Field Transfer (FFT) connector
  - o Connect an ASP to a source: allow calculating ASP pressure at a distance from a source using built-in law with decreasing pressure with distance or user-defined transfer function
- Local Power Connector (LPC)
  - o Connect an ASP to a subsystem: allow calculating input power from ASP in the subsystem

VSEA subsystems
- Mass law correction for curved VSEA subsystem
  - o The radiation CLF can be corrected when modal density is growing with frequency (below ring frequency)

Import
- Update of VSEA model by import of VSEA spectra
- Multi-line/column file import in database
- Importing Nastran geometry when creating a new model

SEA-Foam
- Air Gap with better viscosity prediction and variation of speed of sound with thickness
- Graph of acoustic impedance (real, Imag) of the trimmed system

Documentation
      Update to latest features description

Version 2012.0.4.3

SEA-Foam
- Fluid-gap (with fluid)
  - o Change of the calculation of dissipation due to viscosity to take into account both propagation and rigid wall absorption

SEA+
- Added mass by trims to structural subsystem
  - o The trims attached to a structure are generating added mass and this corrected mass is used in the SEA network. When calculating the trim insertion loss, the parameters of the base plate were sent with the corrected mass which was an error as the trim should have been calculated with the bare mass. The bug has been fixed.
- Support for user-defined insertion loss in junction
  - o When inserting a user-defined IL, the calculated trim is automatically disabled

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Version 2012.0.4.4

SEA+ plate CLF
– Adding flexural static beam formulation in joint

SEA+ Wavenumber
– Correcting wavenumber interpolation function
  o Wavenumber of plates is interpolated to compute the mean band-averaged wavenumber from modal wavenumber
  o For very small plates, the interpolation might miss to give the right wavenumber profile for flexural wave due to too low number of resonances. This has been fixed

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Version 2013.0

SEA+ User-Interface
– Implementation of Project Tree browser
  o The Project Tree displays the list of created SEA+ models which are saved within the same binary file (.dbsv4 extension). The various models created within a Project are sharing the same database and changing one item of the database will affect all models sharing this property
  o A project corresponds the binary file which is saved with *.dbsv4 extension. Several projects can be opened at same time in a SEA+ session
– Model Tree browser
  o Improved subsystem sort
  o Enable/disable junction from tree
  o VSEA mobility in specific branch
– Graph improvement
  o Plot of acceleration available in g

Frequency Band analysis
– Dynamical change of Band type
  o At any time you may change the analysis band type from constant bandwidth up to 1/24th octave
– Automatic interpolation of database items when changing band type
  o Database items are kept untouched when modifying band type. Data are dynamically converted into one band to another when used (for solve of for graph)

Database items
– Materials
  o Structural materials are sorted into homogeneous and orthotropic and can accept thermal expansion coefficient (used in thermal noise source)
– Fluids
  o Salted water Liquid Sodium generic fluids are added. With a generic fluid you can change the temperature and get the acoustic fluid characteristics in return
– Gazeous Fluids
  o The type of fluid includes dissolved gas (as small bubbles) and may be used as other fluid types in cavities and trims
– Default unitary spectra
  o They are generated dynamically from SEA+ GUI and need not to be created in the database. This is to avoid changing the unitary spectrum when changing the Band type

- Nastran import
  - o Import of PBEAM cards and conversion into SEA+ beam property

Mathematical library
- Improvement of accuracy and speed of radiation integrals
  - o The number of steps of k-samples is now user-defined and can be globally modified for all items in the model which call for radiation efficiency computation
  - o Unbaffled radiation formulation has been modified for both real and imaginary parts
  - o Added fluid mass is now bounded when frequency converges to zero
- Spatial windowing correction for trim
  - o The correction of TL by spatial windowing using the radiation efficiency of the acoustic aperture is implemented. 2D-convolution correction is still possible
- Pressurization of structural subsystem
  - o All structural subsystems accepts pressurization
  - o Pressurization modifies subsystem characteristics depending on type related stress plot is available
- Doubly-curved shell of various constructions
  - o Doubly-shell subsystem can be of sandwich (symmetric or not), ribbed homogeneous, ribbed sandwich (symmetric or not) constructions as other shell subsystems
- Acoustic cavities
  - o Accepted generic fluids

Power source
- The power acoustic multipole source is available as another kind of acoustic source

SEA-FOAM Module
- Septum/mass spring layer
  - o Septum can be transformed into resonant septum which is controlled by stiffness below user-defined resonance frequency
- Spatial windowing correction for trim
  - o The correction of TL by spatial windowing using the radiation efficiency of the acoustic aperture is implemented. 2D-convolution correction is still possible

SEA-Shock Module
- Adding a new SEA-Shock source: the thermal noise source
  - o The thermal noise source allows predicting time history responses to relaxation of potential energy induced by heat and stored in a structural subsystem
- Reconstruction of time response in acoustic cavities
  - o Any Fluid cavity can be LMPR receiver and accept time reconstruction
- Reconstruction of time response in beams
  - o A beam can be LMPR receiver and accept time reconstruction
- Improvement of LMPR algorithm for faster reconstruction and less memory usage

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Version 2013.1

Integration of SEAVirt software as SEA+ Module
- New Virtual Tab created in the SEA+ project session
- Substructuration method (similar to previous standalone SEAVirt method) to create VSEA model
- Patch method for creating new MS-VSEA model
  - -from Attraction
  - -from NASTRAN PID
- Full automation and real-time performance optimization of MS-VSEA and VSEA models

Visualisation of multi-scale substructurations per frequency band
- Improved SEA+ solver to handle automatically patch virtual CLF and patch modal density through the various frequency-dependant partitions
- Wavenumber from patch node input mobility

- Surface area calculation of patch from wavenumber & modal density

- Narrow band 3D-force spectrum creation in database (PSD unit); applicable to all VSEA nodes
- Definition of Narrow band 3D force in global physical axis
- Auto-projection of force in the SEA degree of freedom when calculating injected power
- Injected power by narrow band 3D-force calculated in narrow band at VSEA node and band-averaged for SEA solve

- Reconstruction of 3D-nodal response at any VSEA node in narrow band (include translation and rotation responses)

- Improved visibility of the SEA network
  When clicking on subsystem name tag in browser tree, while pressing spacebar, reduces view to coupled subsystems

- Update junction name menu when right-clicking on junction tag in the browser tree
- Subsystems are sorted following type
  o Analytical structure (Beam, Flat Plate, Singly Shell, Doubly Shell)
  o Analytical cavities
  o Virtual subsystems
  o Analytical Sound Probe
  o Infinite Fluid Volume
  o Power Sound Filter

- New local contextual menu item for improved visibility (Hide, Show connected objects, Show/Hide reference Nodes, Show/Hide PID)

- Control of subsystem icon properties on selection (rotation, translation, size, color): CRTL-W on subsystem selection
- Delete key: suppress current selection (no warning for one object select, warning for multiple selection)

Version 2013.1.3

SEAVirt
- Improvement of patch method: move to identical DLF for all patches vs. frequency formulation
- Adding Abaqus modal output file support in SEAVirt
SEA+ Graph
- Adding new preferences to graph (graph pref. per graph type)
- Stable graph color when adding Drag & Drop Graph
SEA+ Modal library
- Adding new pressurization effect in cylinder for highly pressurized shell

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Version 2013.1.4

- − Minor bugs fixed
- − User Interface improvement

Version 2013.1.5

Some changes and fixed bugs
- − Virtual 3D Control: characters not entirely visible
- − Virtual 3D Control command buttons: inconsistent operation
- − Force 3D (point force Narrow band) extrapolation
- − Color, transparency and size of knots not adjustable
- − Dialog box computation option (labels overlap)
- − Panel SEAVirt: group box Solve reorganised
- − Computation not done when opening model with acoustic constraint source
- − Computation of radiation efficiency at low wavenumbers modified
- − Ribbed structures: bug fixed
- − Correction of interpolated option in virtual junction (sometime not saved)

Version 2014 beta (November 2014)

SEA+ 2014 is a major release

Running SEA+ from XML
- − Exporting XML: the model or the current copied selection of objects is exported as XML file
- − Importing XML: a new model is generated from the XML in the current SEA+ model session
- − Running the model directly from the XML: Instructions for driving the calculation are directly written in the XML by the user
- − Command section
    - • Running a given dbsv4 model from the XML through "Load" instruction + path of dbsv4 model
    - • "Output" instruction to write results in the output XML. Any output graphing in the SEA+ GUI may be written in output XML through the "Spectrum" instruction
    - • Replacing dbsv4 model data by input XML data through the "read option" instruction

The input XML does not necessarily contain the full model but only the part you need to modify. In a Dos-like window, you then loop SEA+ as many times you need by reading XML data related to your Load instructions and writing all results in the XML output.

Copy & Paste of GUI objects
- − Select any part of network and use the local menu item Copy Selected Objects
- − While selection is active, paste your copy to another location in current model, in another model or project
- − When copying VSEA subsystems, all geometrical properties are preserved when copying in the same project
- − When copying VSEA subsystems to another project, in-behind FEM information is not copied. The VSEA subsystem is copied as a standard analytical subsystem with user-defined properties

set to VSEA properties. As Copy & Paste of VSEA subsystem requires to know the subsystem type, before copying, the equivalent subsystem type and the section property in the VSEA tab property have to be filled up

New Start-up database to collect all data you always need at start-up
– Start-up database may be seen as a kind of basket in which you sort all kinds of property you need to be available when starting a new project
– Copy & Paste data of current projects in the Start-up database to get it at any time

New Extended Solid Material
– The Extended Solid has frequency-dependent complex elastic parameters for being used by the new Dynamic Laminate construction
– For declaring a frequency-dependent elastic parameter, create first spectra of related moduli in the database and allocate them to the Extended Solid. Elastic material characteristics are made complex through a common damping loss factor spectrum
– When no spectrum is declared, the elastic parameter is static (constant over frequency)

New User-Defined Trim
– Create a User-Defined Trim in the database
– This item groups in a single element all user-defined spectra that may override calculated ones when they are defined
– It is used exactly as a classic TMM trim in the SEA+ network

New Multi-Trim Layer
– The Multi-Trim object is a collection of trims, dispatched on a reference surface area following a given percentage of that surface
– The Multi-Trim is used exactly as a classic trim in the SEA+ network

New Leak object and Multi-Leak definition
– An acoustic Leak is now defined as an object in the database
– In the Leak property tab of an acoustic-to-acoustic junction, add the Leak objects previously created

New subsystem construction with the Dynamic Laminate
– The Dynamic Laminate property is derived from the Static Laminate
– Create first a Static Laminate section describing material, thickness and orientation of the various layers. Both Solid and Extended Solid materials are available in the selection list
– Use this section to create the Dynamic Laminate section and add eventually ribs
– Dynamic Laminate supports plate, singly-curved and doubly-curved shells
– In the property dialog box of the subsystem, select the Dynamic Laminate type and the appropriate section
– The Dynamic Laminate predicts the equivalent DLF from complex elastic parameters of the various layers over the whole frequency range

Colored Energies in SEA network (Extended SEA) – New non-resonant energies shared by subsystems based on Colored Energies theory ("White", "Black" and "Red")
– When excited in a band B by white noise, the response of a dynamic system in B is containing contribution of resonant modes and non-resonant modes.
– Energy of resonant modes is named "White", "Black" energy is the mass-driven non-resonant energy and "Red" the stiffness-driven energy as sketched here below:

- When two systems are coupled together, the strength of the coupling is depending on both the frequency distance between modes and the wavenumber (spatial) distance between them. If their mode shapes have different wavenumber content, the coupling will be weak even if frequency distance is short. When the white-to-white coupling is weak, black or red energies may take over the response as seen in the coupling of cavity-to-plate-cavity in the low and mid-frequency domain.
- Black and Red energies are non-dissipative and cannot be calculated using power flow equations.
- White energy of an emitter subsystem is delivering a force to the coupled receiver subsystem (through a constraint equation) which excites its Black and Red energies.
- The receiver is then radiating to all coupled subsystems its internal Black and Red energies following the next sketch where thick lines are constraints and thin lines power radiation.
- No need to model the indirect mass law connector.
- Non-resonant colored transmission is based on a far more descriptive model than the classical mass law which is restricted to flat homogeneous panels and still needs spatial windowing to become predictive.
- Colored energies take into account modal density, mass and radiation efficiencies in all non-resonant bands to calculate the transmission and are applicable to all subsystem types unlike mass law.
- Give a bottom value for damping optimization, as the drop will be limited by level of black and red energies.

Corrected bugs or modifications

- Cylinder radiation CLF: correction of analytical calculation of cylinder radiation efficiency; when radius was small the argument of the Haenkel function was biased.
- Multi-point structural junction: in previous version the CLF was multiplied by the number of points, leading to non-physical results for large number of points. CCLF is now correctly converging to line connection when increasing number of points.

Version 2014.0.1 beta (December 2014)

- Update SEA+ User's Guide (export SEA model to xml file)
- Bug fixed: non-resonant path computation for virtual subsystems
- Bug fixed: export SEA Model to xml file

Version 2014.0.2 (End of January 2015)

- New Section Metallic Profile added
- Ability to create data on the fly in the DATA part
- Some bugs fixed in 'Copy-Paste'
- Non-resonant path computation improved

Include support for dongle (security device)

SEAWOOD version available

SEA+ Lite version is a dedicated version of SEA+ for wood building industry with restricted mathematical libraries mostly limited to planar construction

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Version 2014.0.3 (May 2015)

Corrections:
- Correction of energy constraint junction on virtual (patch) subsystems when subsystems are defined
- Bug when "Remove Ref outside Std" checked in MultiScale VSEA Creation
- MSVSEA Creation: correction of %Negative modal density criterion extended to <= 0
- MSVSEA Creation: correction to get effectively the best subsystem set found
- MSVSEA front panel: cosmetic changes
- Bug of modes computation with non-symmetric ribbed sections
- Correction of TRIM Insertion Loss in Mass Law correction in acoustic junctions
- Interpolation of imported data from VSEA Model
- CLF of in-plane waves of virtual junctions are interpolation using same function as flexural waves
- Computation of Power Input-Output for patch junctions
- CLF of Structure-Structure junction (extensional and shear)
- 3D View, objects selection

XML
- A new command key is added: Stop_Option press_key="False"

    This will disable key pressed prompt at the end of run

    ```
    <Commands>
    <Output file="E:\Data\xml\Export xml.txt">
            <Subsystem ID="22">
                    <out spectrum_Type="0" />
                    <out spectrum_Type="8" />
                    <out spectrum_Type="31" />
            </Subsystem>
    </Output>
    <Stop_Option press_key="False" />
    </Commands>
    ```

Versions 2014.0.4 and 2014.0.5 (July 2015)

Corrected bugs or modifications:
- When adding constraint connectors between MS-VSEA patches, adding autoclean-up process to avoid redundancy of constraints in function of frequency as patches are already constrained between them
- Interpolation of MS-VSEA energies in LF when found negative due to possible negative CLF
- Septum is now treated as very low elastic plate for constancy of boundary conditions when coupled to porous layer
- Black energy is now propagated in IFV and ASP subsystems allowing to completely remove mass law and switch to colored energy technique for non-resonant energy transfer prediction
- Black energy is now taking into account the total mass of the subsystem (bare mass + added mass from fluid loading and trim)
- Dynamic laminate solver has been improved to avoid ill-behavior observed for some section property definition and due to mode filtering process

- Output input mobility, modal density and mass are now related to the most elastic layer in the set
- The most elastic layer is expected to drive the wavenumber of all other layers especially under acoustic loads. The behavior of this layer is thus representative of the physics of the whole set of layers
- The FFT junction between cavity subsystem and ASP now accepts user-defined transfer of p^2/p^2. Note this measured transfer short-circuits all eventually inserted trims between the interior of the cavity and the exterior simulated by the ASP
- Correction of constraint equation in the matrix

Versions 2014.0.6 and 2014.0.7 (Aug-2015)

- Version 2014.0.6: SEAVirt module: wrong library installed, corrected
- Version 2014.0.7: Correction of Metallic profile computation

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Version 2014.0.8 (Nov-2015)

Corrected bugs and new features:
- Import Pch file: correction of Unit length and mass are not effective in the last mode read
- Ribbed and metallic profile subsystems
- Edit or Create new spectrum   (import text file always in 1/3 Oct)
- Mechanic junction (Strong coupling correction)

- Merge of virtual subsystems between two projects
- Create user defined VSEA model from Pids
- Visibility options
- Copy options

- Correction and improvement of modes and non-resonant libraries

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Version 2014.0.8.5813 (01/12/2015)

Corrected bug:
- Mass law correction

Version 2014.0.9 (23/02/2016)

Corrected bugs:
- Bugged update function of VSEA model
- Crash when opening import file box and setting import file parameters in Preferences as constant band df=0.5 Hz when model is set to 1/3rd octave band. If a new project is created with solve option set to constant band 20 or 50 Hz, the 0.5 df file setting is correctly set and related narrow band spectrum can be created and copied in the 1/3rd octave project.
- Conversion spectrum constant band error. The previous 0.5 Hz constant band rms pressure is not

integrated when used in the session set to different constant bandwidth. OK when in 1/3rd octave.
- Copy&Paste in different projects: subsystems not visible when copied. Subsystem icon and geometry are scaled differently when changing geometry box size in project.

Modifications:
- Shell & double shell Radiation Efficiency computation improved
- Computation of modal density of virtual SEA subsystem improved
- Update LabVIEW and Fortran runtime

Version 2016.0 (10/2016)

Corrected bugs:
- The plot of *Mode Number* of virtual subsystems now corresponds to modal density plot multiplied by bandwidth.
- ASP non-resonant energy transfer is now enabled when coupling ASP-to-structure and structure-to-cavity.

Modification of calculation compared to previous version:
- Modification of structure-to-acoustic CLF when trim is enabled in the junction for better consistency of mass factor when option "Added Trim Mass" is enabled in the coupled panel (see next).

- Added Mass calculation in SEA-Foam trims and modifications of added mass management from trim in SEA+: the insertion loss from trim is computed with the bare mass of the base panel supporting the trim. When *Added Trim Mass* to Panel option is enabled, the radiation CLF of the SEA panel, coupling the trimmed face to a cavity, is increased by a factor that compensates the fact that Trim Insertion Loss refers to the bare panel case. Whether you consider the vibratory path along the various SEA subsystems or the acoustic path through trim, the mass-conversion factor of energy into velocity of a trimmed subsystem (bare mass + added mass by the trim) is now always consistent.
Insertion Loss IL is now always computed referring to the bare structure.

- Modification of calculation when *Is-A Shell* correction is enabled in panel properties. In previous versions, correction was not effective as it worked on a secondary effect induced by curvature. New correction takes into account curvature effect in planar trim computation by removing some incidences from the computation that cannot exist in curved situation. In practice, the amplification of mass-spring trim systems at first breathing resonance is reduced by this correction and may be shifted at higher frequency (depending on curvature) as expected from trimmed cylindrical shell.

- Modification of inter-layer stiffness calculation in the dynamic Laminate theory. Related stiffness terms were previously divided by a factor of mn*pi². This factor is now set to 1 in the theory and provides better fit with experiment for a wider class of structures. As agreement was already good for sandwich panels with previous coefficient, it has been verified that the new formulation still holds good with sandwich theory. For that, it has been necessary to introduce two new elastic coefficients in the description of sandwich core as transverse stiffness is generally much lower than longitudinal one, especially compression. In core layer description E_z and G_z elastic

parameters allow too set the sandwich stiffness in a more representative way by using different values of E and G in transverse and longitudinal planes. All Dynamic Laminate panels made of homogeneous layers have now a decoupling frequency that fits with measurements.

- The calculation of SEA parameters of ribbed-stiffened has been modified to take into account torsional inertia of ribs in the modal density computation.

- Power input to subsystem is now graphed as power sent to emitter subsystem to selected subsystem and not as power flow (difference of received and sent back power)- benefit: always positive quantity. The power flow drawn in 3D model window per frequency in still a view of the signed power flow (difference of power).

- Power dissipated by subsystem is now graphed as internal dissipated power + power lost in coupled subsystems - benefit: always positive quantity.

New calculation capabilities in SEA+ kernel:
- Structural dynamics of corrugated panels as rib-stiffened plate
  o *Remove Skin mass* option has been introduced in the rib panel section property for modeling periodic structures such as corrugated panels where the skin is at the same time the rib.
  o *Corrugation Enabled* is a secondary option where bending stiffness is computed from torsional inertia of the rib-stiffness profile (when enabled). As the corrugated panel stiffness may be controlled by either flexural or torsional inertia of the stiffener when panel is ribbed in only one direction, depending on actual profile geometry, the user can enable/disable this option to shift from bending-controlled modal density to torsional controlled one. These options only apply to State#1 modes of the ribbed panel (low and mid frequency state when wavelengths are larger than rib spacing).

- Turbulent Boundary Layer (TBL) source now supports non-resonant energy generation.

- Black/Red energy enhancement of calculation in all frequency bands (the colored energies constraints are now propagated in the whole system through series of SEA+ solves).

- Sound Transmission Loss (STL) calculation function: calculate the generalized STL between two cavities within any SEA network and direct plot of related spectrum in dB.

New Graph Library :
- A new graph library is implemented in SEA+ for graphing all outputs. This brings additional features such as:
  o Overall rms value,
  o Graph update,
  o Send graph data to database...
- New graph functionalities are fully documented in SEA+ user-guide.

SEAVirt module:
  FRF solver:
- User-preferences can now be stored. Current setting may be saved as Default Setting with a restore to Default function.
- The number of FRF solvers has been limited to the two which are the most useful.

- Engineering units used in the imported FEM files have to be defined by the user as previously but internally all data is converted into SI unit (previously FEM was stored in user units in database).

VSEA add-on:
- Duplicate function accessible by contextual menu on a selected substructuration in the VSEA browser in Virtual SEA tab.
- In VSEA, solver, adding extra criterion for selecting the best node-grouping as optimized SEA partition: when criterion *Modal Dens.>0* is checked, now the number of modes must also be >= 1 in the analysis bandwidth for all detected subsystems (avoid non-physical "always positive" modal density solutions).
- VSEA solver setting preferences can also be set to Default and restore from default.

MS-VSEA add-on:
- In MS-VSEA model page, new Button: Create user-defined substructuration from MS-VSEA partition (send selected band-MS-VSEA partition under VSEA tree as user-defined partition).
- Visualisation of associated PID when scrolling MS-VSEA subsystems.
- Alphabetic sort of items in MS-VSEA list.
- MS-VSEA solver setting preferences can also be set to Default and restore from default.

In SEA+ GUI:
- Optimization of loading time when editing virtual SEA subsystem properties.
- In virtual subsystem properties, new check box to automatically set VSEA DLF to same spectrum than their analytical expander (when declared).
- When the virtual wavenumber cannot be computed as in the case of nodes located on FE solid elements, the wavenumber is computed in the virtual SEA frequency domain from the analytical expander (when declared).

GUI Improvements:
Graphing Data
- New plots are available:
    - Interface force to subsystem
        Click in subsystem local menu to call the new Graph/Interface Force menu
    - Max Bending Stress to subsystem
        Click in subsystem local menu to call the new Graph/Max Bending Stress menu

Faster inputs in the Database
- The Shortcut button "+" that allows to directly add a database item in a property dialog box has been extended to all list-boxes where database items are required.

Improved object viewing and handling
- Extended listing of subsystem and junction properties from which you can change collectively data of selection.
- New tool bar items to:
    o Rotate subsystems
    o Lock/Unlock object position,
    o Hide/Show trimmed objects
    o Align objects in 3D model page
    o Copy 3D model page as image to clipboard
- New hide/show menu for all objects and new categories available in the 3D model browser.

- New Mask/unmask menu as new object property. Allow to work with Hide/Show function keeping some objects always masked.
- Mask and lock properties added to objects. If Lock is enabled at subsystem level, unlock command will be ineffective (Tool bar Lock/unlock applies only on objects set locally to unlock).
- New categories in Model tree browser for sorting cavities, active sound probe, virtual and analytical structural subsystems. Junctions are sorted in acoustic-acoustic, LPC active sound probe, virtual-acoustic, virtual-virtual and so on with collective Hide/Show property.
- New quick view setting of subsystem and only connected ones with their junctions. In Model tree browser, click in subsystem or junction item while maintaining mouse button down to see only see only coupled ones. Efficient when virtual-virtual CLF are masked.

Improved subsystem and coupling updating
- In Structure-to-Acoustic junction properties: New "*Update From Connected Structure*" check box with percentage setting of coupled area to automatically update coupling area when coupled subsystem dimension is changed in subsystem property.
- In Cavity properties, new "Update trim dimension" check box to automatically update the size of the trim to the area size of the cavity. Work only with one trim applied in the cavity.
- In cavity property, new button "Update Trim From Connected Structures" to setup cavity trims to all trims enabled in connected structures to the cavity. The trim area is set in that case to the structural trim dimension times the percentage of coupled area, defined in the related junction.

SEA-Shock module:
New available sources:
- SRS as constraint source
  SRS specification may be now used as an input source. SRS is applied to a subsystem which is becoming the source subsystem. SRS is automatically converted into acceleration time domain signal with as similar as possible same SRS and this acceleration signal is used as constraint acceleration to the subsystem in the frequency domain to calculate the transfer to a receiver and the related mean time history from which is computed the receiver SRS.

- Acceleration as constraint source
  An acceleration time history can now be directly used as source of shock the same way than SRS input.

More database items in SEA+ session:
SRS and acceleration time history spectra with import from dataset 58 (universal file format)

Stress items (when graphing stress in structure). These items are currently generated by the graph export to database function when plotting Mean Stress of a structural subsystem.

Modified Extended material
Adding Gz and Ez elastic parameters

SEA-Foam module:
- Mean mass et mean DLF calculation method has changed (modification in averaging results at discrete incidences)
- Curvature effect implementation
- Interface between SEA-Foam and SEA+ has been improved (see Added Mass calculation in Modification of calculation section)

Version 2016.1 (01/2017)

Corrected bugs:
- Mas Law (with trim): bug fixed
- Fixed bug (crash): Open file by external call (double clicking in SEA+ file)
- Small corrections in calculations of transmission loss, CLF
- Joint added in "Black energy" computation

Graph:
- Change of data dB(A.. D)
- Add blink of plots when data are copied to clipboard with (ctrl+C)
- Bug fixed in (ctrl+V) in create new spectrum

Version 2016.1.1 (02/2017)

Corrected bugs:
- Mas Law
- Modes computation shell with rib
- SEA+ freezes when changing fluid in trim

Modification - improvement:
- Computation of junctions structure-structure

Miscellaneous:
- Back to runtime VC++2013 due to some problem with no full updated computer

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Version 2016.1.2 (05/2017)

Corrected bugs:
- Beam modes computation
- Trim with heavy fluid
- Fluid loading in virtual subsystem (equivalent subsystem and heavy fluid)
- Partial copy of junction acoustic-acoustic with mass law
- Copy of junction FFT Structure to Infinite Fluid Volume with trim

Modification - improvement:
- Graph: more efficiency and enabled to move and resize legend
- Library trim, correction of damping computation
- Small correction in mechanical junction library
- Copy/paste faster

Added:
- Graph power flow inputs and losses
- Library trim compute masking coefficient and graph

Version 2016.1.3 (01/2018)

- In list mode, update and save data when changing list parameters
- Copy of junction with Mass Law
- Correction of computation of trim damping added when copying virtual subsystem
- Flat Plate edition form, mass and surface updated
- Correction library Mode, computation interpolation (1/f or 1/sqrt(f)) at low frequencies.
- Set to false by default for virtual subsystems in "use equivalent wave-number"
- Correction in laminate computation (removing the modes filter)
- Update SEA Model when data changed (laminate data)
- Change junction acoustic structure view in mode list
- Correction of modal density interpolation below first mode
- Correction of post-processing of MS VSEA subsystems (power input-loss)
- Correction of SEAVirt interface
- Correction : button remove in trim layer interface not visible in some windows system
- Optimization of function "update junction names"
- Correction: sort nodes in LMPR module
- Correction of graph when data are plotted in g
- Correction of plot time history
- Correction of " Enable Show Result lmpr"
- Correction of import trim in xml files
- Change name of subsystems name when create MS-VSEA (from Pids)
- Improvement of the interface of "Update virtual Extension"
- Possibility to open several projects at the same time (need more than one license)
- Change of virtual wavenumber computation
- Added reading of Nastran element CTRIA6
- Improvement of the interface of "Update virtual Extension" (copy options for junctions)
- Modification of the non-resonant calculations for the structure-structure and acoustic-acoustic junctions
- Modification of CLF calculations :
    - Connection of shell or doubly-shell with acoustic cavity when flexural wave-number is user defined
    - Connection of Virtual Subsystem (patch) with structure or acoustic cavity
- Change in Multi-scale VSEA criterions tests in Attraction Patch process.
- Cavity coupling, Correction of CLF calculations (diffusion)
- Correction of calculations for narrow-band responses
- Improvement of the narrow band data graph
- Change of non-resonant computation in junction structure-structure and acoustic-acoustic
- Deleting non-resonant path in virtual-virtual junctions
- Correction of trim masking coefficient computing

- Low frequencies interpolation when changing frequency band
- Computation of black energy through trim in a junction
- Computation of black energy mass
- Computation of power flow in ASP-Acoustic junction
- Subsystem mass for non-resonant computation
- "View List" (reset calculated data in linked junctions)
- Non-resonant computation in virtual subsystems

- Copy of junction constraint energy (transfer spectrum error)
- bug fixed in list view when changing junction color
- bug fixed in "Update Trim from Connected Structures" in Cavity

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Version 2018.0 (11/2018)

Note: Previous models will be automatically translated in 2018 version

Added the 3D Geometry Support:
- SEA objects can be described by new geometry primitives called "Shapes"

- Compatibility with older SEA objects is maintained by adding "face" parameters to subsystems and older models are automatically converted to new format

- Subsystems can be coupled now by their common faces and a face may be linked to a Shape

- GUI has been modified to support Shape creation through a new "**3D Geometry" tab** window including floating palettes (**Geometry**, **Shapes** and **SEA Elements**) and a dedicated toolbar:

  o Allow the creation of shape, subsystems and junctions built from shapes

  o Contain measuring tools (lengths, angles and radii of curvature)

  o Support of FEM NASTRAN mesh to convert "PID's" into Shapes with Auto-detection of Shape dimensions whenever it is possible

- When a subsystem is linked to a Shape, it takes its geometry properties from the Shape. If the Shape is modified, geometry of subsystem automatically follows the change

- Shape geometry can be overridden to become user-defined in the subsystem or in the junction

- Shapes can be allocated to any structural and acoustic subsystems and junctions

- A new Preferences palette (from 3D-Geometry toolbar) allows to set color and size of the various displayed geometrical objects: nodes, elements, PID's, shapes, subsystems and junctions

Changes in Subsystems:
- Subsystems are created from faces

  o Several faces for cavity (6 by default)

  o One face for structure that can be divided into zones

- The trims are placed on subsystem faces or zone only

- Subsystem dimensions can be calculated from geometry or user-defined

- Subsystems can be drawn by icons or geometry, if shapes are assigned to them

- Adding "Shrinked View" of subsystems with shapes

Changes in Junctions:

- Junctions parameters can be calculated from the geometry (common elements) of the subsystem

- The connection of two cavities is made by the common face

- The connection of a structure with cavity is made with one structural face (and side) and acoustic face (acoustic face data are overridden by structural face)

- The trims in the connections are located on the connected faces on subsystems

Subsystem Icons and Shape Views:

- The efficiency of the non-geometrical icon-based representation of SEA models has been preserved

- One-click button allows shifting from Icon view to Shape view

- In Shape view, the mean normal to each subsystem can be drawn using one-click button for clearly seeing the orientation of each subsystem and distinguishing inner and outer faces (for exact trim location)

Import of VAONE Models:

- VAONE SEA models files in XML format are imported from the 3D Geometry window and are All calculations are re-directed to corresponding numerical routines of SEA+ and VA-ONE models are fully executable after import and displayed in a similar way than their original GUI

Added Thermogram Visualization for Post Processed Data:

- In each frequency band, energy levels are drawn using color-scaled levels

- Thermogram works in both icons and Shape views

Added a Default Setting for Each Kind of Subsystems:

- You can select what are the default parameters for each newly created subsystems including ASP, PSF and IFV

Numerical Improvements to SEA+ Calculation Kernel:

Structural Junction CLF:

- o Improved theoretical formulation and numerical implementation for line, multipoint and point junctions

- o Suppression of the short-line junction (redundant as covered by line + spatial windowing)

- o New line-to-multipoint junction type

Structural-to-Acoustic CLF:

- o Improved internal calculation using modified interpolation routines

Virtual SEA Module Improvement:

- Support of Shape display in VSEA subsystems and junction
- Faster CLF computation in the virtual frequency domain

SEA-Foam Module Improvement:

Adding Inverse Foam Function:

- o Material properties of poroelastic, limped foam and fiber layers can be generated from experimental data (complex normal acoustic impedance measurement form Kundt's tube)
- o Generated materials from impedance are extracted from submitted measurement using a non-linear inverse solver and directly stored in the Material database of SEA+

Adding Curvature effect correction in TMM planar calculation of IL and TL:

- o Correction of Transfer Matrix Method calculation for taking into account curvature effect on IL and TL. This correction is performed in the planar TMM matrix of both thick and thin panels (work in the mid-frequency range) and supports singly and doubly-curved curvatures

New Module: SEA-Cyl (Optional Module of SEA-Foam Module):

SEA-Cyl Module integrates AcouCYL^{TM}, a spectral method for the vibroacoustic modeling of multilayered cylindrical systems developed and owned by CSTB, the French Technical Research Center of building industry in Grenoble.

SEA-Cyl allows performing IL and TL predictions using TMM calculation formulated in cylindrical coordinates and provides better description of curvature effects than the planar correction described here above.

Note: SEA-Cyl module is dedicated to cylindrical structures. In SEA+ GUI, SEA-Cyl can be in one-click substituted to SEA-Foam calculations when the supporting structure is curved (singly-curved and doubly-curved shell SEA+ subsystems).

SEA-Shock Module:

- Minor bugs corrections
- Better management of "SRS as input" source

Version 2018.0.1 (05/2019)

Bugs fixed and corrections:

- Inverse foam module cannot be opened or SEA+ crashes at the opening of the Foam module.
- SEA+ crashes when importing VAOne xml file version 1.12.1.0
- Minor corrections in coupling VSEA and analytical panel.

- Minor corrections in the 3D creation module (Shapes)
- Fixed bugs in SEAVirt module, some of the windows remains opened after the closure of SEA+
- Double shell, correction of the calculation of the radiation coefficient when the parameters are defined by the user (min radius instead of radius Y)
- Minor bugs correction in module LMPR

Improvement:
- Import VAONE File
- Changing visualization objects "treeview & treenode" (faster response)
- Optimization (parallelization) of some libraries
- Improved shape detection
- Creation of 3D junctions, improved detection of common areas
- Creation of 3D junctions when the subsystems do not have common nodes
- Add of the possibility to connect a pyro source on a point junction with a beam
- Ability to import STL geometry files

Version 2018.0.2 (06/2019)

Bugs fixed and corrections:
- Inverse foam module cannot be opened or SEA+ crashes at the opening of the foam module.
- SEA+ crashes when importing VA One xml file version 1.12.1.0
- Import SEAVirt data
- Format of copy data to clipboard

Improvement and News:
- Add button check the connection of two subsystems (select the common junction on the treeview)
- Add plot psd force spectrum (excitation force)
- Add plot Auto Power Spectrum (time history)
- Add plot Spectrum (PSD) and band integrated (RMS) for shock source with time history
- LMPR Modified calculations (pseudo modes)
- Import spectra modification
- Add a new data import interface (dataset 58)
- Introduction of "Master Shape" for the calculation of structure parameters

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Version 2018.0.3 (09/2019)

Bugs fixed:
- Import multiple files (module "Foam from experimental data")
- Color of junctions in 3D visualization
- Import VAONE xml file (enable non-resonant always false)
- Import VAONE fluid in the cavities are set to default
- Correcting the display error when creating shapes
- Correction of closed cylinder layout when creating subsystem with 'shape'
- Correction of alphabetical order in the shapes list view when the user changes a name
- Correction in the STL file import module (algorithm eliminating nodes)
- Fixed bug crash plot post-processing (after opening database)

- Correction of surface calculation of doubly-curved and close cylinder shapes
- Fixed object visibility options (add missing subsystem types)
- Thermogram correction (null values)
- Fixed bug display list junctions "Baffled"

Improvements:
- Update import VAONE xml file
- Source shock calculations on point link
- Change in the presentation of the Shape palette
- Extension searches junctions when more than two subsystems are selected
- Add button 'centering on visible elements' on the 3D windows

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Version 2020 (04/2020)

Bugs fixed:
- Creation of virtual subsystems (VSEA) : criteria are sometimes not taken into account
- Opengl scale (in some cases the scales are not respected)
- Switch button of interface 3D

Corrections:
- Correction and improvement of laminate library
- Correction and improvement of junction library

Improvements and additions:
- Refinement of creation of subsystems with SEAVirt (new indicator added)
- Reverse Foam calculation : addition of new calculation (bottom air thickness parameters)
- Added shock source narrow band calculation
- Pids Names imported, when reading data (geometry and materials)
- Shock postprocessing export to wave files
- Creation of equivalent section from several shapes (creation shape, materials and equivalent section)
- Modification of User Defined CLF in the Structure-structure junction (only in the user defined spectrum range)
- Foam : Add option in foam type
- Improvement of interface graphics drawing (OpenGL)
- 3D geometry windows improvement (pids lists, shape lists, retractable palettes)
- Update virtual subsystems extension from 3D interface subsystems data
- Update of a standard SEA model from the data of a virtual model (User Defined Spectra, indirect junctions)
- Addition of the type of subsystem and the section in the shape data
- Addition of a new palette of tool for selection and export of nodes label in Nastran text format

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SEA+ Version 2020.0.1 (28/07/2020)

Corrections:
- In the Geometry 3D window, sometimes the SEA Elements palette disappears and no longer

appears
- Autoconnect, junction creation is wrong when shapes are made of 3D solid mesh
- Minor bugs (acoustic-virtual CLF, virtual subsystem edition)

Update:
- Load XML data in invariant culture info

Improvement:
- Creation of point junction when nodes are grouped in packets

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SEA+ Version 2020.1 (21/09/2020)

Correction:
- Minor bug fixed (data conversion and import)

Modifications:
- Switching from framework 4 to 4.6.2
- Visualization of node-to-node modal transfers and possibility of exporting them to a file

Improvements:
- The modal solver can process a larger amount of data
- Universal file (unv) data import extended to other type of spectrum
- Reading of RBE2 cards (for future connections)
- Addition of a node search function in the SEAVirt module