About SAMTECH Group

Founded in 1986, SAMTECH is now the European leading provider of scientific analysis/optimization software (FEA, MBS, MDO), professional solutions and associated services. SAMTECH develops and commercializes:

"***General-purpose software tools***": this SAMTECH offer includes the general linear and implicit non-linear Finite Element Analysis package SAMCEF with the CAD/CAE modeling environment FIELD, the general explicit and fast dynamics code EUROPLEXUS; the task management and optimization platform BOSS quattro; TEA Mecano and TEA Thermal CAA V5 Based as non-linear thermo-mechanical solution embedded in CATIA V5 and SAMCEF Gateway CAA V5 Based, the SAMCEF integrated interface within CATIA V5.

"***Professional solutions***": this SAMTECH offer is based on its general-purpose software tools and is dedicated to specific domains of application like rotor dynamics, modeling of composite structures, mechatronic modeling of machine-tools, modeling of large deployable or inflatable structures, modeling of high voltage substations, modeling of pipes for automotive industry…

"***Third party and customized solutions***" like the SAFE tool (fatigue analysis of aeronautic structures) and the Application COMPOSITES (analysis of aeronautical structures made of composite materials) from AIRBUS, where SAMTECH provides its clients with services such as development, reengineering, packaging and deployment of proprietary professional solutions on the customer site.

"***Customized multi-physics solutions***", based on OOFELIE. OOFELIE is commercialized by Open Engineering, the SAMTECH subsidiary, that allows SAMTECH to be present on the multi-physics design markets and to provide services for the development of original highly coupled analysis solutions covering specific needs. Open Engineering offers specific services and supports on multidisciplinary analyses. The company brings valuable expertise in the simulation of strong coupled mechanical, thermal and acoustical problems as well as piezoelectric systems, accelerometers, ultrasonic piezoelectric devices and some MEMS applications.

Visit **www.samcef.com** for further details on SAMTECH Product/Service offer!

Some References

Universities

ULG - ASMA (Belgium), UNIVERSIDAD NACIONAL DEL LITORAL (Argentina), DELFT UNIVERSITY OF TECHNOLOGY (The Netherlands), STANDFORD UNIVERSITY (USA), CENAERO (Belgium)…

Research Centers

CETIM (France), ONERA (France), MEMSCAP (France)…

Business Partners

SAMTECH (Belgium), ESA - European Space Agency (The Netherlands), SODIE, WSL - Wallonia Space Logistics (Belgium)…

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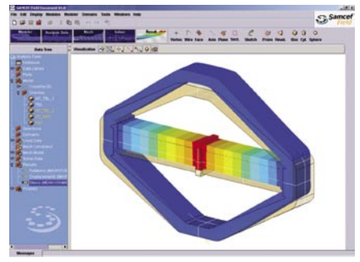
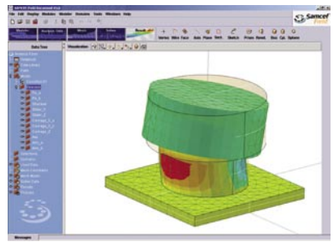
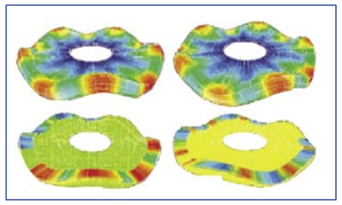
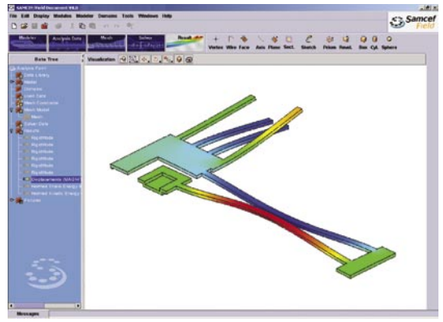
open engineering

OOFELIE PiezoElectric









OOFELIE PiezoElectric, driven by SAMCEF Field: the solution for the analysis of **piezoelectric systems**.

SAMTECH, Integrating CAE towards Professional Solutions

OOFELIE PiezoElectric, driven by SAMCEF Field, provides engineers and analysts with unique capabilities to analyze piezoelectric systems, such as sensors and actuators, ultrasonic motors and accelerometers. With OOFELIE PiezoElectric, driven by SAMCEF Field, you are getting at the core of the physics in one conveniently integrated simulation package.

OOFELIE PiezoElectric, driven by SAMCEF Field, is a Virtual Prototyping tool for the analysis and design of piezoelectric systems. Through the use of its modeling capabilities, it becomes possible to start simulating the performance of such systems even before a single physical prototype is built. Design changes can be evaluated faster and in a more affordable manner, reducing the number of actual prototypes needed to achieve a required design maturity, thus accelerating significantly product development. Thanks to such a tool, the engineers acquire a capability to isolate and analyze the effect of each parameter. With such insight available at their fingertips, information can be quickly gained to correct or improve previous designs efficiently, knowing which are the influent factors.

Reduced design time, improved quality and reduced costs are some of the benefits one can now reap from using OOFELIE PiezoElectric, driven by SAMCEF Field…

ANALYSIS

OOFELIE PiezoElectric, driven by SAMCEF Field, allows specific static, modal, harmonic ant transient analyses for piezoelectric systems.

The direct piezoelectric effect consists in the ability of certain materials to generate an electrical potential in proportion to an externally applied force. The inverse piezoelectric effect refers to the reciprocal effect by which the application of an electric field induces a deformation of the piezoelectric material. These dual effects, which can be used simultaneously, are increasingly being used today in the application of piezoelectric materials.

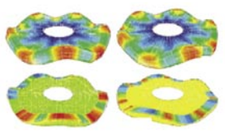
The general, three-dimensional, models offer generalized methods that can be adapted and used for many different applications in the transportation (aircraft, automotive), equipment (machinery, motors, sound systems), electronic appliances, biomedical and building industries for instance.

Some applications cover examples such as:

ULTRASONIC MOTOR

Piezoelectric ultrasonic motors offer great advantages over conventional electromagnetic motors (such as torque to size and weight ratio, reduced noise, small and compact, etc.).

The ultrasonic motor consists in a stator (a fixed circular ring), and a rotor, (another circular plate) which is compressed on the vibrating ring and is free to rotate. A set of piezoelectric patches are located on the stator. With the application to those patches of a suitable harmonic electric voltage, a travelling wave can be generated along the ring. A. The presence of the travelling wave induces a rotation of the rotor in the opposite direction by contact.



Orthogonal eigen modes of the stator.

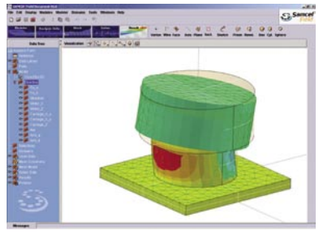
The modeling of the ultrasonic engine involves the use of 3D elements. Several analyses can be performed. For instance:

- Modal analysis to determine the right frequency of the signal to apply to the piezoelectric patches;
- Knowing the right frequency, an harmonic analysis can be done to simulate the harmonic response of the coupled system;
- The direct integration method using the HHT (Hilbert-Hughes-Taylor) algorithm can also simulate the transient response of the system (from start-up to established harmonic response, for example).

ACTUATORS AND SENSORS

The strongly coupled static, modal, harmonic and transient behaviors can be easily simulated with OOFELIE PiezoElectric to optimize the input and output parameters.

In the case of actuators, the analysis focuses mainly on the mechanical response due to an electrical loading and in the case of sensors, on the inverse phenomenon. The harmonic response of accelerometers enters in this class of problems.



Piezoelectric accelerometer - Electric potential and shape for 5th vibration mode.

MODELING ENVIRONMENT

OOFELIE PiezoElectric is driven by a user-friendly integrated graphical user interface (SAMCEF Field) for the modeling, the analysis and the post-processing of piezoelectric systems.

SAMCEF Field, a complete and interactive user environment providing all the tools necessary to design, simulate and analyze a range of configurations, has been tailored to approach efficiently the field of piezo-electricity. Its visual and hierarchically arranged layout will guide you through all the steps of model preparation, resolution procedure and analysis.

A CAD modeler, as well as import capabilities from other leading CAD providers, is integrated for modeling and data preparation. As data are directly defined on the geometry, users can easily switch system components modeling level from idealized rigid representation to full Finite Element description.

Parameterized data entry is easily done using contextual pull-down menus and pop up boxes using a wide selection of preprogrammed functions for the definition of time and frequency varying properties and boundary conditions.

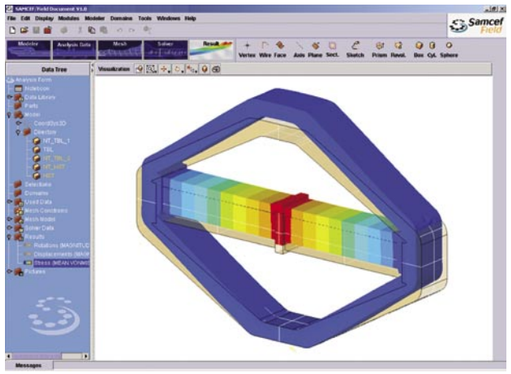
As soon as the analysis is completed, the results are easily accessible from a simple click in the navigator. Results may be displayed in different forms over the whole model or through user's defined cross-sections to study detailed behavior. In addition to all the state-of-the-art standard graphic outputs (i.e. X-Y plots, isovalues, animations, etc.), results may also be inserted in tabular forms in the analysis report. SAMCEF Field is common to all the group's solutions, allowing other analyses to be performed on the same model as for piezoelectric simulations.

SOLUTION ALGORITHMS

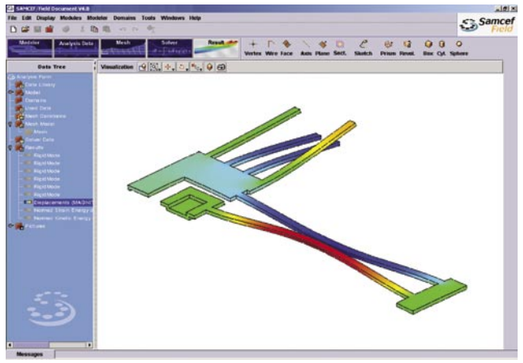
To accurately model the behavior of piezoelectric systems, the strong coupling between the mechanical and electrostatic problem is considered in the solution approach.

Electrodes can be added, whether "passive" (fixed potential) or "active" (constant but unknown isopotential value, whether in closed or open circuit).

It is also possible to add and connect multiple RLC circuit elements to model the connected circuitry. Specific algorithms are available to adequately address dissipative elements.



Piezoelectric actuator - Electric potential on the piezo elements and resulting deformed shape of the actuating arm



Electric potential and deformed shape for the first eigen mode of resonator.

DOCUMENTATION

For direct access to information, the Users Guide and Help manual (including many examples) are available via your favorite navigator (HTML).

PLATFORMS

OOFELIE PiezoElectric, driven by SAMCEF Field, is available on Windows and Linux platforms.

Technical Characteristics:

Finite element method for piezoelectric systems

- Element types:
  - Structural domain
    - Volume (Hexa, Tetra, Prism: 1st and 2nd order, 3 DOF/node)
    - 3D rod
    - 3D beam (Line, 1st order, 6 DOF/node, constant cross-section)
    - Lumped mass
  - Piezoelectric domain
    - Volume elements (Hexa, Tetra, Prism: 1st and 2nd order, 4 DOF/node)
- Constraints:
  - Piezoelectric domain
    - Fixed potential
    - Imposed constant potential
    - Isopotential (same value for a set of DOF)
  - Structural domain
    - Clamp, locking and rotation locking
    - Prescribed translation and rotation
- Loading:
  - Piezoelectric domain
    - Point charge
    - Line charge density
    - Surface charge density
  - Structural domain
    - Force
    - Force/unit
    - Pressure
- Transient & Harmonic loading:
  - All loading with time frequency function defined using
    - Analytical expression
    - Predefined expressions: step, ramp, sinus (max, freq., phase), square, trapeze
- Materials:
  - Linear
  - Isotropic, transversally isotropic
  - orthotropic

Analysis:

- Linear analysis:
  - Static
  - Modal
  - Harmonic (Direct, Projection in coupled modal basis)
  - Transient
  - Substructuring (Craig & Bampton)
- Post-processing:
  - Single DOF, sum of displacements
  - Constraints (tensor values, Von Mises) on nodes (mean on elements)
  - Isovalues for scalar data and vectors for vector data
  - Deformed shape, isovalues and vectors on deformed shape

Special:

- Possible integration with OOFELIE VibroAcoustics module

Future releases:

- Thermal coupling (pyro-piezo-electricity)
- Large displacements
- Coupling with electrostatic

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