

Customer References

Using SYSTUS, Tractebel Engineering evaluates plant life extension of Nuclear Power Plant



"At Tractebel Engineering, our team of structural integrity experts is using SYSTUS extensively for fracture mechanics, design of new equipment and more recently to evaluate nuclear plant life extension. Fatigue analyses are performed with SYSTUS on various nuclear components."

Olivier Meessen, Head of Modelisation & Calculations-Nuclear, Tractebel Engineering

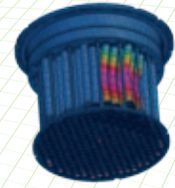


Fatigue analysis of a reactor coolant pump.
Courtesy of Tractebel Engineering

AREVA makes a breakthrough in Nuclear Power Plant simulation for optimal safety



...AREVA recognizes the unmatched computing performances and reliability of SYSTUS for the design, analysis and components assessment in compliance with nuclear regulations...



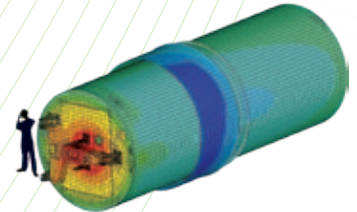
Large model of reactor vessel's upper internals.
Courtesy of AREVA

Regulatory assessment studies: SYSTUS structural analysis of the EPR reactor building mechanical equipment



· Dimensioning of the maintenance personnel airlock and equipment hatch for the reactor building including stress analysis, buckling simulation, dynamic and elastoplastic behavior;

- Validated assessment of structural behavior;
- Conformity with EPR Technical Code for Civil works (ETC-C) regulation.



Dimensioning of the reactor building personnel airlock.
Courtesy of NFM Technologies

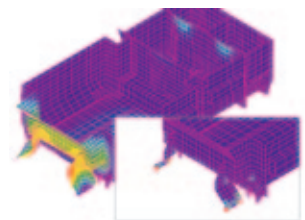
Better control of physical phenomena through simulation



"We rely on SYSTUS for our structural mechanics and vibratory studies whether for fatigue or fracture analysis, behavior assessment analysis or correlation with experimental measures.

Because it handles smoothly regulatory analyses and deals with coupled physics it is of great help for our analyses in various fields such as civil and mechanical engineering and transportation."

Jean-Louis MICHEL, CAE Director, AMETRA Expression Numérique



Vibratory analysis of high-speed train traction transformer tank model.

Corporate agreement with EDF-Septen



The contract deals with SYSTUS mechanical studies for the design and maintenance of components in Pressurized Water Reactors.

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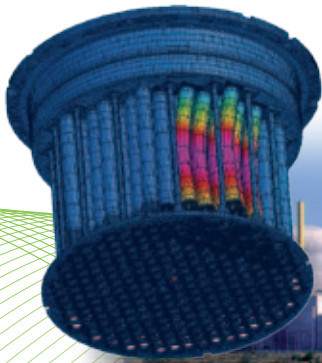
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ABOUT ESI GROUP

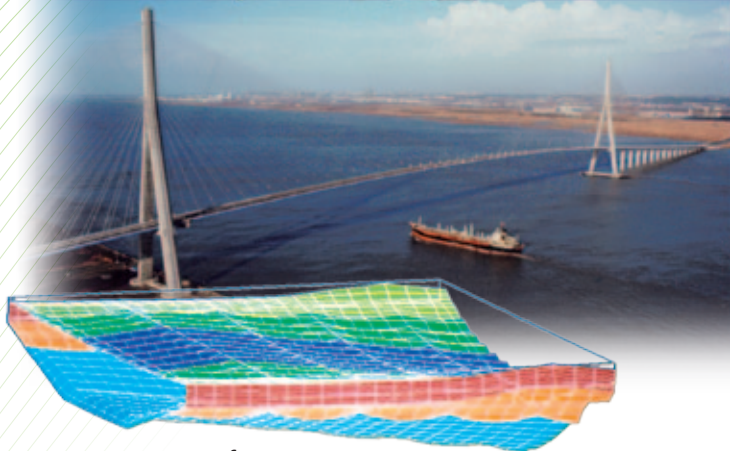
ESI is a pioneer and world-leading provider in Virtual Prototyping that takes into account the physics of materials. ESI boasts a unique know-how in Virtual Product Engineering, based on an integrated suite of coherent, industry-oriented applications. Addressing manufacturing industries, Virtual Product Engineering aims to replace physical prototypes by realistically simulating a product's behavior during testing, to fine-tune fabrication and assembly processes in accordance with desired product performance, and to evaluate the impact of product use under normal or accidental conditions. ESI's solutions fit into a single collaborative and open environment for End-to-End Virtual Prototyping. These solutions are delivered using the latest technologies, including immersive Virtual Reality, to bring products to life in 3D; helping customers make the right decisions throughout product development. The company employs about 900 high-level specialists worldwide covering more than 30 countries. ESI Group is listed in compartment C of NYSE Euronext Paris.

Multiphysics Engineering Simulation Suite

SYSTUS



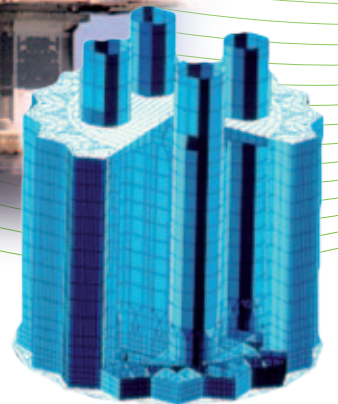
Courtesy of AREVA



Courtesy of SETRA



Courtesy of HMDC



Multiphysics Engineering Simulation Suite

How to perform optimized design of complex multi-domain systems in civil and mechanical engineering, energy and transportation?

The Multiphysics Engineering Simulation Suite: SYSTUS was developed following close cooperation with leading international firms. SYSTUS brings a complete answer to analysis challenges in mechanics, heat transfer, and electrotechnics.

Benefits

- Industry-validated tool to perform regulatory analyses (ASME, RCC-M...);
- Supports a wide variety of materials, including advanced metallic material laws;
- Handles complex realistic simulations from elementary components to fully integrated systems;
- Reduces cost through the integration of best practices and easy automation;
- Masters design and manufacturing processes up to operating conditions, thanks to various coupled physics;
- Speeds up the structural analysis process by offering dynamically loaded libraries and an embedded scripting language to design custom applications.

Quality

· Certification

To meet our customers' expectations for quality products and services, ESI Group is ISO 9001 certified, guaranteeing full conformity with ISO 9001 international standards.

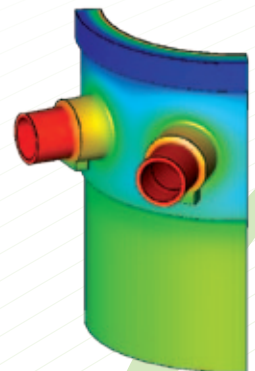


· Standards

ESI Group complies with strict standards for nuclear applications such as 10CFR50, NQA1, Q-N-100 and Q-N-300 (specific to AREVA) and SGAQ (specific to EDF).

Thermo-mechanical analysis

Leveraging SYSTUS' extensive library of Finite Elements, including high order elements, engineers performing advanced studies can manage large displacements, rotations and strains, as well as buckling and post-buckling. Such an extensive modeling scope in the coupled mechanical and thermal fields helps improve technical solutions and validate final design choices.



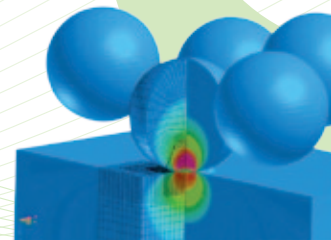
Temperature on reactor nozzles.
Courtesy of AREVA

Thermal simulation

The software provides advanced thermal features, including conduction, diffusion, enthalpic model, radiation, thermal contact and forced convection. Users can accurately predict temperature distribution and carry out reliable thermo-mechanical analyses.

Advanced materials

"SYSTUS helps model and optimize the behavior of structures thanks to state-of-the-art material models and advanced material laws. These laws cover a large range of phenomena: fatigue and ratchetting (Chaboche and Armstrong-Frederick), damage, brittle and ductile fracture (Weibull, Gurson/Leblond, Wilkins, Lemaitre), and creep (Chaboche, Razakanaivo, Norton)," says **Philippe GILLES**, AREVA International Expert in Mechanics and Materials.

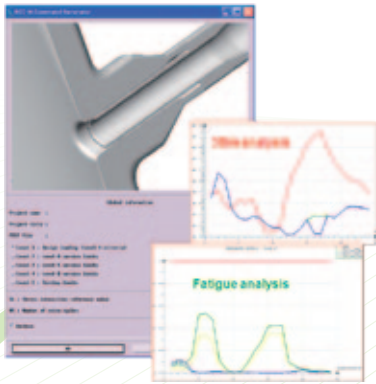


Mechanical surface treatment.

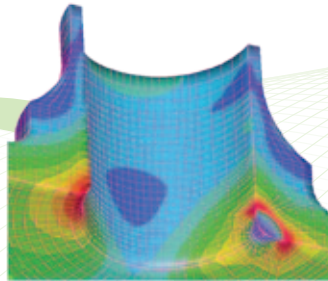
Nuclear Power Plant (NPP) regulatory and fatigue analysis

NPP engineers benefit from unique certified modules inside SYSTUS to perform regulatory analyses for the design of nuclear components (class 1&2). The software complies with nuclear codes and standards: **ASME**, **RCC-M** (section 3200), **RSE-M** codifications...

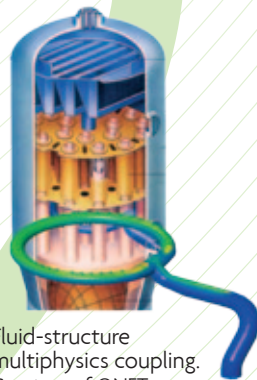
In addition to regulatory fatigue analysis, SYSTUS offers a realistic approach based on large 3D models and advanced fatigue criteria (such as Dang-Van criteria).



RCC-M level A analysis.

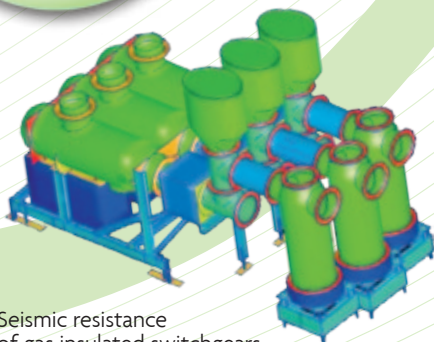


Crack initiation in a nozzle.
Courtesy of Tractebel Engineering



Fluid-structure
multiphysics coupling.
Courtesy of ONET
Technologies

Multiphysics Coupled Analyses



Seismic resistance
of gas insulated switchgears.
Courtesy of AMETRA Expression Numérique

Dynamics and seismic

SYSTUS handles eigen-values and eigen-vectors real or complex, even for structures containing non compressible and non viscous fluid. The modal dynamic response module manages time and history (with possibility of contact non-linearities) or harmonic response, stochastic response, mono and multi spectral analysis. Thanks to these advanced features, engineers can perform structural integrity assessment analysis of various structures such as: components or assemblies, pipe systems, buildings, bridges...

Fracture mechanics

“SYSTUS is one of the most advanced numerical tools in the field of fracture mechanics. It allows for the consideration of various materials and mechanical situations such as brittle and ductile fracture, fatigue. The implemented models, ranging from ready-to-use ones to highly sophisticated ones evaluate a great variety of industrial test cases,” declares **Professor J.-B. Leblond**, Member of the French Academy of Sciences and Professor at the Université Pierre et Marie Curie.

Coupled analyses

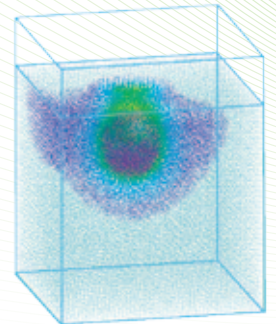
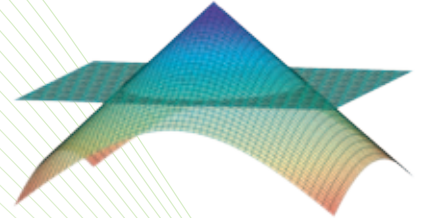
Users perform multi-domain analysis by coupling with a variety of physics such as: metallurgy, electrical engineering, and Fluid-Structure Interaction using ESI's simulation solutions.

“The coupled analysis solutions of SYSTUS include numerous multiphysics capabilities. Advanced and robust algorithms are available for the simulation of manufacturing processes allowing perfect control settings and to develop innovative technologies,” says **Professor J.-M. Bergheau**, from Université de Lyon, Ecole Nationale d'Ingénieurs de Saint-Étienne (ENISE).

One Engineering Simulation Suite for your Innovative Projects

The Multiphysics Engineering Simulation Suite: SYSTUS supports a series of R&D projects:

- X-FEM technology for advanced fracture mechanics. Joint project with AREVA to speed-up crack propagation analysis.
- Level set-based topological optimization method for weight reduction. RODIN (Robust Optimal Design in INdustry) governmental funded project with EADS and Renault among others. The aim of the RODIN project is to develop a new topological shape optimization tool for solid thermo-mechanical structures.
- FPM innovative mesh-free technology for thermo-hydraulics applications and Fluid-Structure Interactions developed in partnership with Fraunhofer Institute. SYSTUS coupling with FPM overcomes meshing issues for complex geometries. This method brings new capabilities for solving problems involving multiphysic interactions.



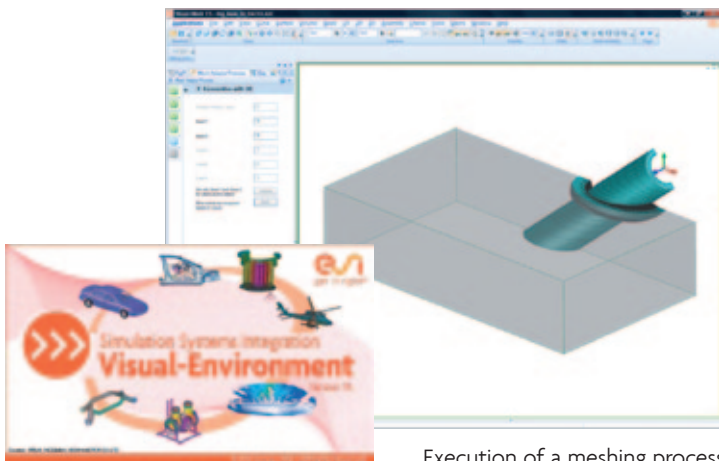
Solver performance



SYSTUS reliable solvers offer scalable performances from workstations to High Performance Computing platforms (including SMP and DMP paradigms) to drastically reduce execution time for all your projects.

ESI-Intel collaboration fully contributes to reaching increased productivity and efficiency answering the most demanding simulation needs.

Visual-Environment for improved productivity



Execution of a meshing process.

ESI's software suite is supported by a flexible and open engineering framework sharing a common platform, addressing multiple simulation domains. Visual-Environment is an integrated and versatile virtual prototyping platform for improved productivity. It encompasses the entire Computer-Aided Engineering (CAE) process from interfacing with Computer-Aided Design (CAD) to model set-up and post-processing all using a single core compute model. Visual-Environment incorporates best practices and enables project planning, execution and management for company's overall Product Lifecycle Management.