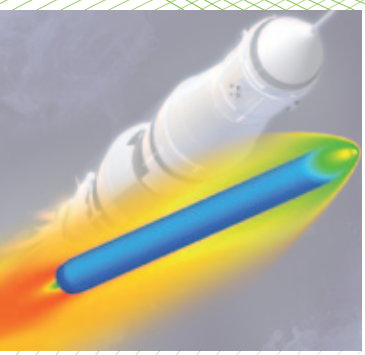
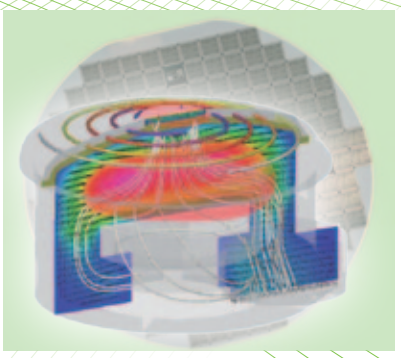
multiphysics

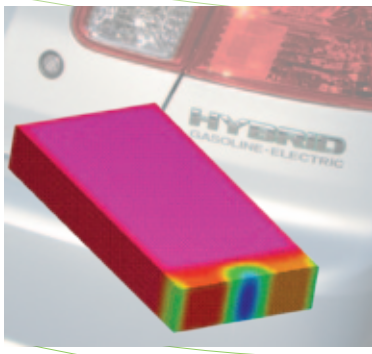
get it right®

ACE+ Suite

Computational Fluid Dynamics & Multiphysics Solutions







ESI's Computational Fluid Dynamics & Multiphysics Solutions

Driving innovation at the limits of physics

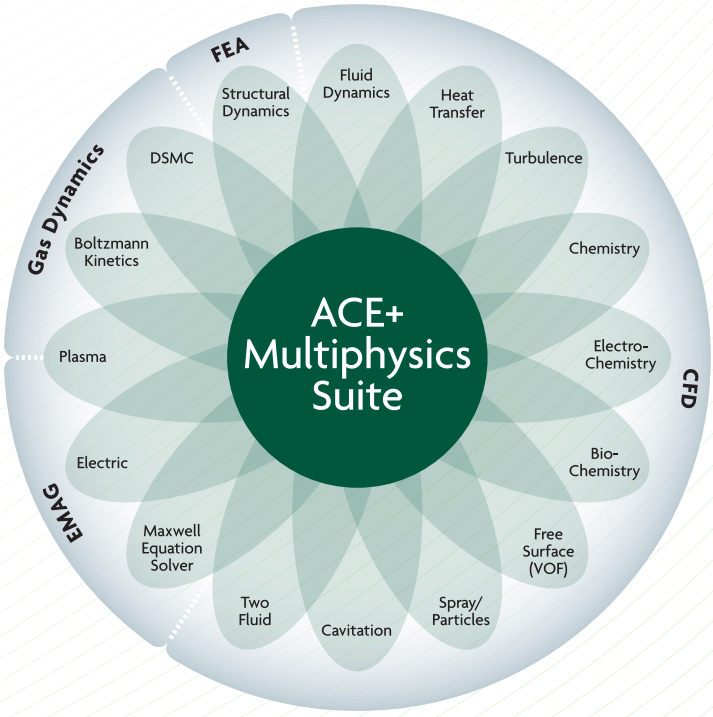
ESI is a global technology pioneer providing cutting-edge software solutions for realistic simulation over a wide range of physics and disciplines. We understand the increasingly important role multiphysics plays in product design, and the need global development teams have for open-environment, realistic simulation solutions.

Our expertise encompasses many aspects of multi-physics modeling. Whether you need to simulate multiscale, fluid, thermal, chemical, biological, electrical, or mechanical phenomena, ESI's unique suite of simulation products enables you to gain insight about your projects from conception to completion, thus making it the ideal choice for real world simulation.

ACE+ SUITE

ACE+ Suite is an engineering design and analysis tool used by various organizations worldwide because of its unique ability to model a wide range of physical and chemical phenomena – from vehicle aerodynamics to microfluidics, from semiconductor processing to modeling of fuel cells and batteries.

Furthermore, the ACE+ Suite works on all computer hardware/software systems. It is designed for parallel computing on high performance workstations and PC clusters.



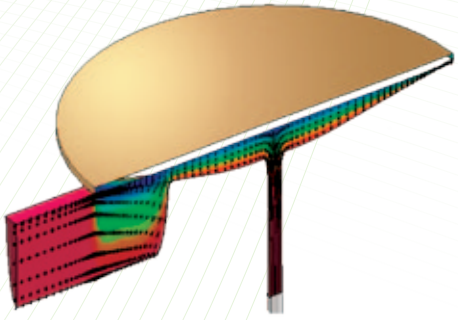
Benefits

- Use realistic multiphysics models to make critical design decisions at an early phase of the product design cycle
- Automate your processes for speed & consistency using included simulation management tools
- Refine and optimize your design with industrial scale multiphysics capability representing the full product complexity
- VisCART meshing solution can reduce weeks of meshing complex geometries to hours... with very little experience required
- Professional visualization & presentation of your results in less time means your work can be communicated effectively
- Interact with your simulations through your iPhone or iPod Touch at anytime or anywhere

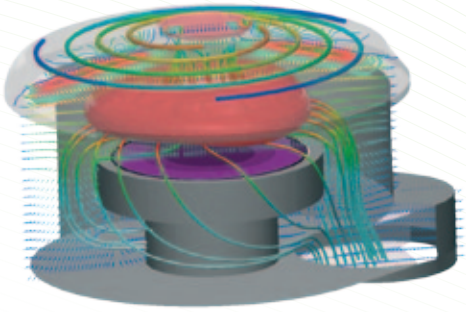
CFD-ACE+

CFD-ACE+, the foundation of the ACE+ Suite, includes a modular and expandable structure which provides users with a high degree of flexibility in terms of functionality and cost. CFD-ACE+ includes state-of-the-art numerical and physical models, and advanced pre- and post-processing modules. All grid technologies are supported, including multi-block structured, general polyhedral unstructured, arbitrary interfaces, and moving and deforming grids. It also supports most of the commonly used Computer Aided Design (CAD), Computer Aided Engineering (CAE), and Electronic Design Automation (EDA) data formats for optimum flexibility.

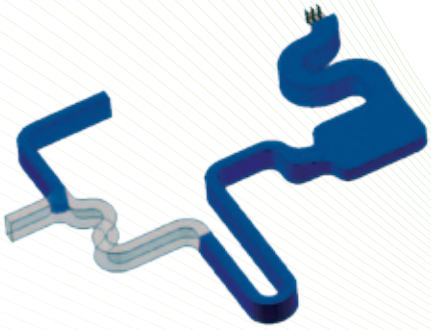
CFD-ACE+ is offered as a base package that includes flow, heat transfer and turbulence. Other optional industry-specific packages are offered for biotechnology, plasma, semiconductor, MEMS, aerospace and fuel cells.



Fluid Structure Interaction of Bead Meso Pump



Inductively coupled plasma reactor



Flow with Surface Tension in a Microfluidic Channel

CFD Consulting Services

Solutions for your Fluid Dynamics Applications with Specialized Engineering Services

With more than 30 years of experience, ESI's CAE specialists in various disciplines help customers fill resource gaps, improve internal knowledge and get better results in a shorter time. A close collaboration between ESI engineers, Universities and industrial partners is the key to advanced engineering methods.

ESI's services offering comprises of a large global team with expertise in Computational Fluid Dynamics (CFD) and Multiphysics. This group provides innovative solutions to complex CFD and Multiphysics simulation challenges ranging from automotive to aerospace and defense applications such as Vehicle Aerodynamics and Climate Control including Passenger Thermal Comfort, Vehicle Thermal Management, Powertrain, Brake Cooling, Hybrid Electrical Vehicle (VEH), Fuel Cell, etc.

Benefits of Working with ESI's CFD Services Team

- Short term access to experienced engineers to cover peak loads in CAE projects
- Worldwide available resources in various engineering disciplines
- Attractive cost structure
- High experienced project managers worldwide as the direct contact in local language
- Access to latest technology trends to cover the simulation of new and innovative development projects

ESI's ACE+ Suite has been designed to meet the growing demands of complex CFD and multiphysics simulation challenges. This covers a wide range of industries such as transportation and energy (fuel cell and batteries), in addition to specific applications: vehicle aerodynamics, climate control, thermal management, engine simulation, etc.

Transportation

ACE+ Suite provides a complete interactive analysis package for transportation applications and is used to solve the most challenging problems facing the industry.

Underhood Thermal

- Transient and Steady State Temperature
- Heat Shields
- Hybrids: Cooling of Batteries and Motor Controls

Aerodynamics

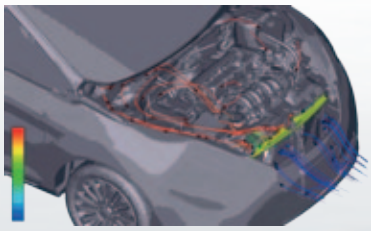
- External Aerodynamics
- Optimization at Design Stage Using Adjoint Solver

Powertrain

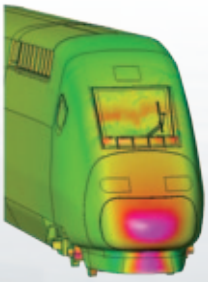
- Engine Airflow
- Turbocharger Performance
- Hybrids: Fuel Cells and Batteries
- Exhaust
- Spark Plugs
- Snow Ingestion

Comfort

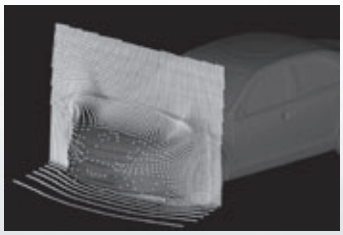
- Passenger Temperature
- Duct flow



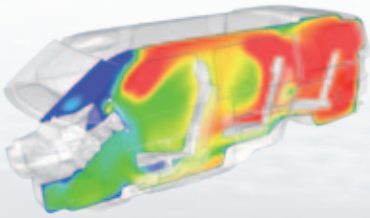
Front end sealing analysis for air change temperature evaluation



Simulation of aeroacoustic noise of the TGV, using ESI's PAM-FLOW (advanced computational fluid dynamics technology used to simulate unsteady flow phenomena). Courtesy of ALSTOM Transport



Snow Ingestion Analysis using particle release method



Interior Cabin Environment - climate control

" Alstom Transport relies on ESI's numerical simulations to optimize the cooling system of our locomotives. "

Etienne Grappein - **Alstom Aeraulic Expert**

" ESI is known for its cutting edge technology and being a leader in Simulation-Based Design. ESI provides a comprehensive solution for vehicle development, which is why I wanted to have them as part of our team. This is an opportunity for us to work side by side with ESI, learn from its experts, use its tools, and deliver an even better product to the market faster. "

Daniel Panoz, President - **Panoz Auto Development Company**

Aerospace

ESI provides high fidelity engineering analysis services and software tools for a wide range of aeromechanics applications. Along with ACE+ Suite this includes CFD-FASTRAN, a state-of-the-art multiple moving body capability for simulating the most complex aerospace problems including missile launch, maneuvering and staging, and aircraft flight dynamics & store separation.

Flight Aerodynamics

- Lift/Drag
- Store Separation (Missile Launch)
- High Mach and Low Speed Flight

Launch and Separation

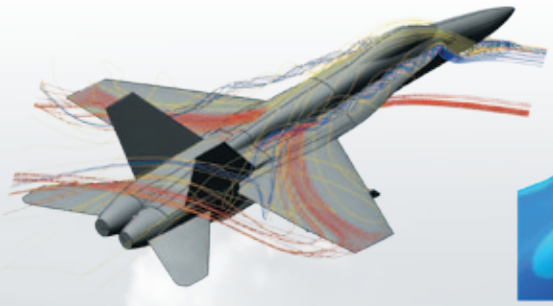
- Fuel Tank Slosh
- Fuel Tank or Stage Separation
- Aerodynamics

Spacecraft Re-Entry

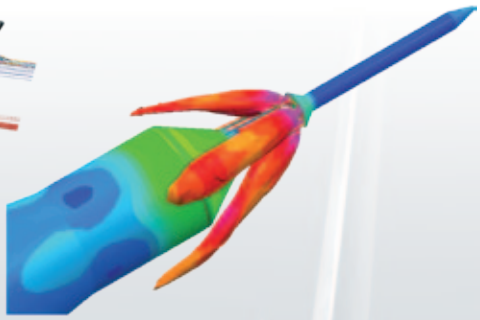
- Surface Heating Due to Re-Entry
- Survivability of Electronics or Crew Due to Capsule Heating

Cabin and Cockpit Comfort

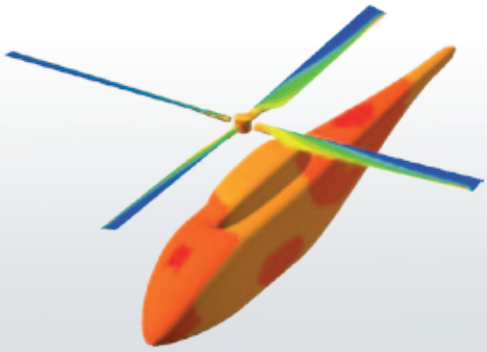
- Cooling and/or Heating
- Pressurization



F/A 18 Hornet aerodynamics



Separation of Saturn V Launch Escape System



Simulation of a rotorcraft in hover using overset grids

“ CFD-FASTRAN results were applied to the design of a new experimental program, aiming at better quantifying the effects of an unsteady pressure environment on separated nozzle flow-fields and evaluating alternate nozzle concepts. ”

David Perigo, Launcher Aerodynamics Group of **ESA/ESTEC**

“ Aeronautical Development Agency (ADA) uses CFD-FASTRAN, density based Navier-Stokes solver coupled with finite rate chemistry model to capture flow and thermochemistry profiles of a highly under expanded jet. The continued technical support offered by ESI has been vital in completing the project within the scheduled time and cost that helped in intelligent design of experiments. ”

B. Kannan, Scientist, Propulsion Systems, **Aeronautical Development Agency**

Energy - Fuel Cells and Batteries

ACE+ Suite provides the ideal environment to conceptualize, analyze and optimize the fundamental fuel cell components and systems.

Fuel Cell Performance

- Electrochemical Performance
- Local Heating
- Water Management
- Ion Pollution
- PEM, DSMC, and SOFC Experience

Nuclear

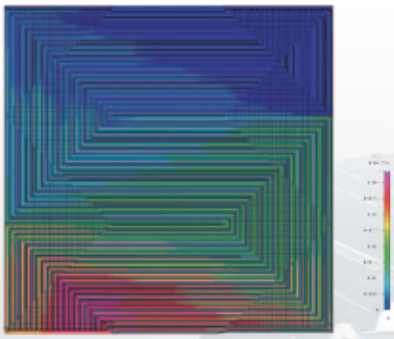
- Heat Exchange Modeling

Thermal management

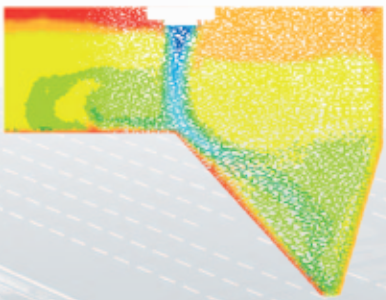
- Heating and/or Cooling of Assembled Units/Packs
- Packaging

Battery performance

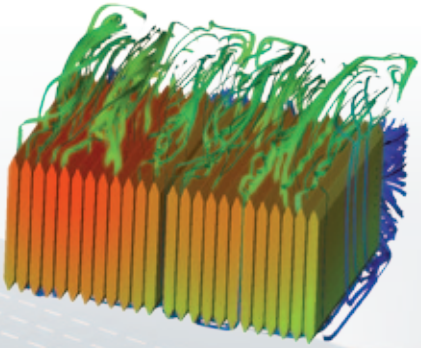
- Steady-State Simulation
- Electrochemical Performance
- Local Heating



Hydrogen concentration distribution



Thermo-hydraulic analysis in the water downcomer
Courtesy: Comex Nucleaire



Air flow structure designed to cool the battery cells with minimum air pressure drop, cell to cell temperature variation, and lowest maximum temperature

“ CFD-ACE+ has helped us significantly increase the efficiency and life of proton exchange membrane fuel cells (PEMFCs) by reducing variations in flow between and within individual cells.. ”

Sanjiv Kumar, **Ballard Power Systems, Burnaby, British Columbia**

Courtesy Ballard Power Systems

Thin Film - Semiconductor and Solar

ACE+ Suite provides the unique capacity to perform high fidelity three-dimensional simulations of heat and mass transport with complex multi-step gas-phase and surface reactions for industrial applications.

Semiconductor manufacturers

- Chemical Vapor Deposition Processes
- Plasma Enhanced Processes
- Electroplating
- Nano-Scale Simulation of Surface Features

Solar

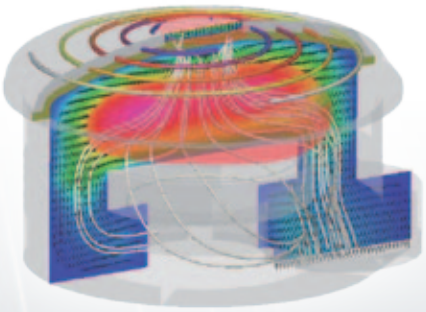
- Thin-Film Photovoltaic Manufacturing

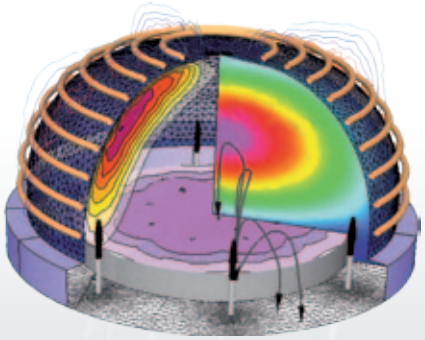
Industrial Coatings

- Surface Coatings for Surgical Instruments
- Bearing Surfaces

MicroElectroMechanical (MEMS) Devices

- Lab-on-a-chip for Biotech Applications
- Micro-Mirrors





Plasma-enhanced Chemical Vapor Deposition (PECVD) Reactor simulation

“ CFD-ACE+ provides you with advanced simulation tools helpful for cost-effective decisions, and ESI supporting staff is the one you can always rely on.”

Gaetano Panvini, **STMicroelectronics**

“ We find CFD-ACE+ especially useful as a predictive tool of laminar flow properties in the micro channels we devise on lab cards.”

Dr. Fred Battrell, **Micronics Inc.**

“ The CFD-ACE+ simulation package has been an integral part of our design process for many years. Virtual prototyping with CFD-ACE+ does deliver accurate results reliably and leads to performance improvements, yield enhancements and significant cost savings.”

Martin Dauelsberg, **AIXTRON AG**

Example of architectural lighting with white LEDs

AROUND THE WORLD

ESI Group
Headquarters
100-102 Avenue de Suffren
75015 Paris
France
T. +33 (0)1 53 65 14 14
F. +33 (0)1 53 65 14 12

EUROPE

BENELUX & SCANDINAVIA

ESI Group Netherlands
Radex Innovation Centre
room 4.57
Rotterdamseweg 183 C
2629 HD Delft
The Netherlands
T. +31 (0)15 2682501
F. +31 (0)15 2682514

CZECH REPUBLIC & EASTERN EUROPE

MECAS ESI
Brojova 2113/16
326 00 Pilsen - Czech Republic
T. +420 377 432 931
F. +420 377 432 930

FRANCE

ESI France
Headquarters
Parc d'Affaires Silic
99, rue des Solets - BP 80112
94513 Rungis Cedex - France
T. +33 (0)1 49 78 28 00
F. +33 (0)1 46 87 72 02

ESI France
Le Récamier
70, rue robert
69458 Lyon Cedex 06 - France
T. +33 (0)4 78 14 12 00
F. +33 (0)4 78 14 12 01

SPAIN

ESI Group Hispania
Headquarters
Parque Empresarial Arroyo de la Vega
C/ Francisca Delgado, 11.
Planta 2ª - 28108 Alcobendas
Madrid - Spain
T. +34 91 484 02 56
F. +34 91 484 02 55

ESI Group Hispania
Regional Office
C/ Valencia, 63 (Oficinas AGORA)
08015 Barcelona - Spain
T. +34 93 508 51 72
F. +34 93 508 51 71

GERMANY

ESI GmbH
Headquarters
Mergenthalerallee 15-21
D-65760 Eschborn - Germany
T. +49(0)6196 9583 0
F. +49(0)6196 9583 111

ESI GmbH
Werner-Eckert-Str. 6
81829 München - Germany
T. +49 89 45 10 888 0
F. +49 89 45 10 888 18

ESI GmbH
Kruppstr. 82-100 / ETEC V5-105
45145 Essen - Germany
T. +49 (0)201 125 072 0
F. +49 (0)201 125 072 24

ITALY

ESI Italia
Via San Donato 191
40127 Bologna
Italy
T. +39 0516335577
T. +39 0516335578
F. +39 0516335601

SWITZERLAND

Calcom ESI
Parc Scientifique EPFL / PSE-A
CH-1015 Lausanne
Switzerland
T. +41 21 693 2918
F. +41 21 693 4740

UNITED KINGDOM

ESI UK
1 Robert Robinson Avenue
The Magdalen Centre
Oxford Science Park
Oxford OX4 4GA
United Kingdom
T. +44 (0) 1865 784 830
F. +44 (0) 1865 784 826

ASIA

CHINA

ESI China
Room 16A, Base F Fu Hua Mansion
No. 8 Chaoyangmen North Av.
Beijing 100027
China
T. +86 (10) 6554 4907
F. +86 (10) 6554 4911

INDIA

ESI India
Indrakrupa #17, 100 feet ring road
3rd phase, 6th block,
Banashankari 3rd stage
Bangalore 560 085
India
T. +91 98809 26926
F. +91 80401 74705

KOREA

Hankook ESI
157-033, 5F MISUNG bldg., 660-6
Deungchon-3Dong, Gangseo-ku
Seoul
South Korea
T. +82 2 3660 4500
F. +82 2 3662 0084

SOUTH-EAST ASIA

ESI Group
South-East Asia
2, Jalan Dato Haji Harun,
Taman Tayntor, Cheras
56000 Kuala Lumpur,
Malaysia
T. +60 (12) 6181014

JAPAN

Nihon ESI
Headquarters
15F and 16F Shinjuku Green Tower
Bldg, 6-14-1, Nishi-Shinjuku
Shinjuku-ku, Tokyo 160-0023
Japan
T. +81 3 6381 8490 / 8494
F. +81 3 6381 8488 / 8489

Nihon ESI
Kansai Branch Office
Nishi-Nihon Sales office
5F Advance Esaka Bldg,
8-10 Toyotsu-cho - Suita-shi,
Osaka 564-0051
Japan
T. +81 6 6330 2720
F. +81 6 6330 2740

Nihon ESI
Chubu Branch Office
9F Daisan Horiuchi Bldg.
4-6-23, Meieki
Nakamura-ku, Nagoya-shi,
Aichi 450-0002
Japan
T. +81 52 589 7100
F. +81 52 589 7001

AMERICAS

USA

ESI North America
32605 W 12 Mile Road,
Suite 350
Farmington Hills, MI 48334-3379
USA
T. +1 (248) 381-8040
F. +1 (248) 381-8998

ESI North America
12555 High Bluff Drive
Suite 250
San Diego, CA 92130
USA
T. +1 (858) 350 0057
F. +1 (858) 350 8328

ESI North America
6767 Old Madison Pike
Suite 600
Huntsville, AL 35806
USA
T. +1 (256) 713-4700
F. +1 (256) 713-4799

SOUTH AMERICA

ESI South America
Av. Pedroso de Morais,
1619 cj.312
São Paulo - SP CEP 05419-001
Brazil

T./F. +55 (011) 3031-6221

info@esi-group.com

ABOUT ESI GROUP

ESI is a world-leading supplier and pioneer of digital simulation software for prototyping and manufacturing processes that take into account the physics of materials. ESI has developed an extensive suite of coherent, industry-oriented applications to realistically simulate a product's behavior during testing, to fine-tune manufacturing processes in accordance with desired product performance, and to evaluate the environment's impact on product performance. ESI's products represent a unique collaborative and open environment for Simulation-Based Design, enabling virtual prototypes to be improved in a continuous and collaborative manner while eliminating the need for physical prototypes during product development. The company employs over 750 high-level specialists worldwide covering more than 30 countries. ESI Group is listed in compartment C of NYSE Euronext Paris. For further information, visit www.esi-group.com.